NGINEERING
LIBRARY

# MECHANICAL ENGINEERING

SEP 9 1946

SEPTEMBER 1946

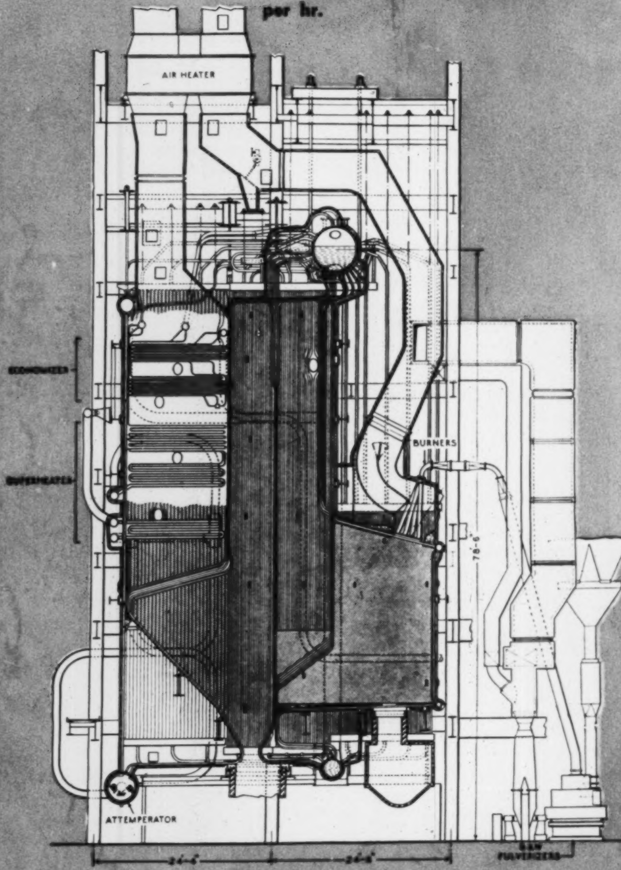
# Steam for Southwark . . .

## B&W BOILERS

## selected for *NEWEST* Philadelphia Electric Station

**B&W OPEN-PASS BOILER**

Four units of this design are being installed in the Southwark Station of the Philadelphia Electric Co. Each unit has a maximum continuous capacity of 850,000 lb. of steam per hour at 850 psi, and 900 F, with a 3-hr peak of 935,000 lb. per hr.



Reliability and simplicity were the foremost aims of the Philadelphia Electric Company in constructing and equipping its new Southwark Station, which will carry a large portion of the system's capacity. Comprehensive study of plant requirements and service conditions led to the selection of four B&W Open-Pass Boilers for this, the first station in the system to use only pulverized coal.

A factor, too, in the selection of B&W units for Southwark was Philadelphia Electric's satisfactory experience with similar B&W Boilers at its Chester Station.

On the basis of these two criteria—through study of plant needs, and past performance—B&W Boilers were indicated as the most attractive units from the standpoint of investment and operating costs consistent with estimated load conditions and capacity factor for the station's anticipated life.

Your requirements probably differ from those at Southwark. But whatever they are, B&W welcomes the kind of thorough analysis and close comparison that influenced the selection of B&W Boilers there. It's a good way to go about choosing the right boilers for low overall power cost—and B&W is ready to help power engineers in *any* plant to achieve just that.

G-339

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

**BABCOCK & WILCOX**

THE BABCOCK & WILCOX CO.
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: ALLIANCE AND BARBERTON, O.; AUGUSTA, GA.

# MECHANICAL ENGINEERING

*Published by The American Society of Mechanical Engineers*

Volume 68 Number 9

## *Contents for September, 1946*

THE COVER . . . . . . *Operating a Keller Duplicating Machine*
*Photograph, Courtesy Fairchild Engine and Airplane Corporation*

NUCLEAR ENERGY . . . . . *A. L. Baker* 775
NUCLEAR ENERGY AS A POWER SOURCE . . . . *H. G. Bowen* 779
EFFECT OF MC MAHON BILL ON NUCLEAR-ENERGY APPLICATION *Brien McMahon* 782
THE ARMY'S RESEARCH PROGRAM . . . . *H. S. Aurand* 785
INDUSTRIAL DEVELOPMENT IN THE SOUTHEAST . . *J. P. Ferris* 787
DIESEL POWER OF M.S. "HENRY FORD II" . *Malcolm McLaren* 792
RECONVERSION PROBLEMS IN AIRCRAFT TOOLING *N. A. Lombard* 794
RESISTANCE WELDING WITH STORAGE-BATTERY POWER . *J. D. Gordon* 797
MANAGEMENT RESEARCH AND THE ENGINEER . . *W. E. Hill* 802
RESEARCH FOR TOP MANAGEMENT . . . . *J. P. Kottcamp* 803
AN IMMEDIATE MEASURE TO STRENGTHEN THE PROFESSIONAL AND ECONOMIC POSITION OF THE ENGINEERING PROFESSION . . . . . . . 807
FOREIGN TRADE, FOREIGN INVESTMENT, AND AMERICAN PROSPERITY . . . . . . . *L. W. McKenzie, Jr.* 816

BRIEFING THE RECORD . . . 818
A.S.M.E. BOILER CODE . . . . 834
BOOKS RECEIVED IN LIBRARY . . 835
A.S.M.E. NEWS . . . . . 836
CONTENTS OF A.S.M.E. TRANSACTIONS . . 852

INDEX TO ADVERTISERS . . . . 118

**OFFICERS OF THE SOCIETY:**

D. Robert Yarnall, *President*
K. W. Jaffe, *Treasurer* C. E. Davies *Secretary*

**PUBLICATION STAFF:**

George A. Stetson, *Editor* Frederick Lask, *Advertising Mgr.*
K. W. Clendinning, *Managing Editor*

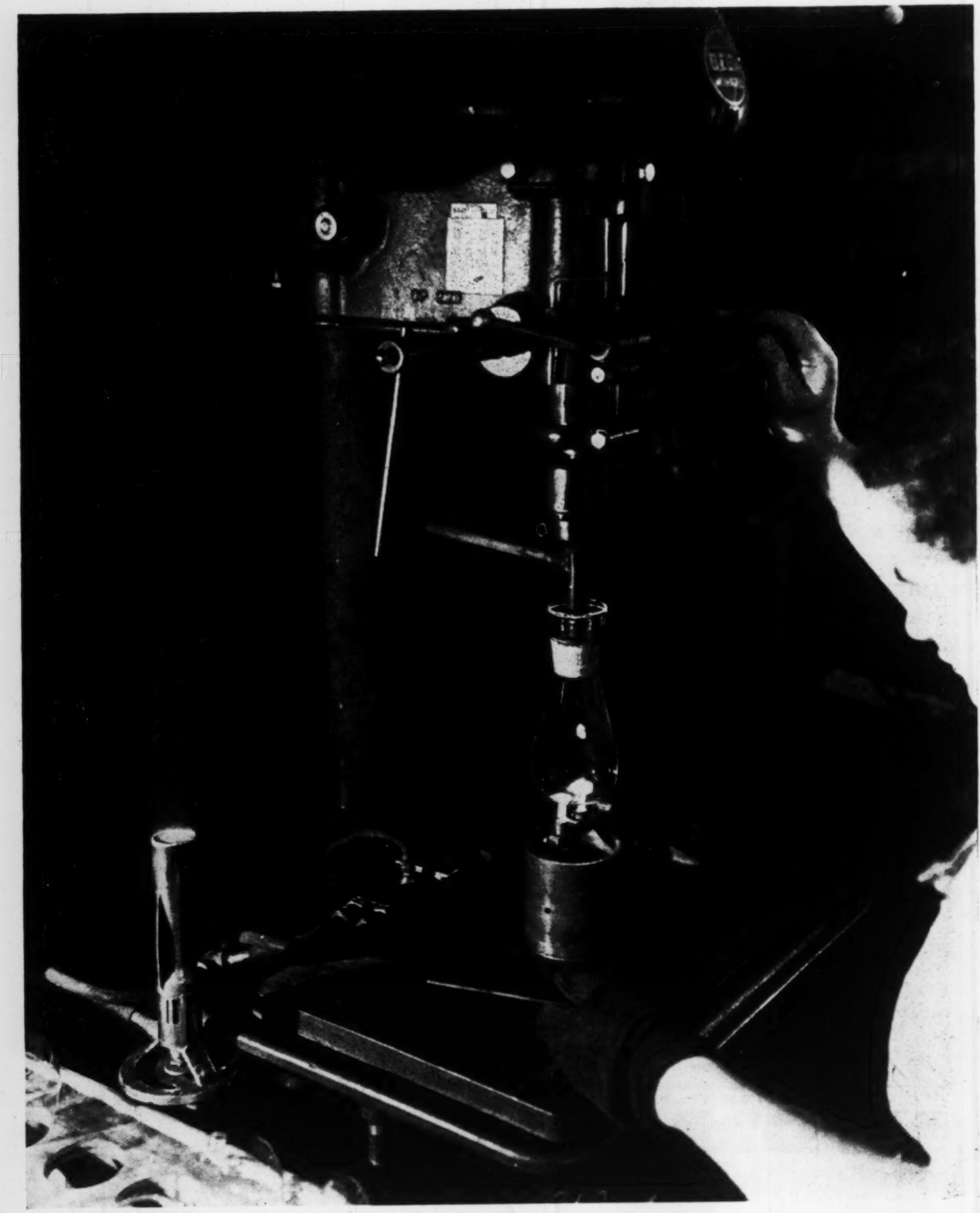
**COMMITTEE ON PUBLICATIONS:**

L. N. Rowley, Jr., *Chairman*
W. A. Carter J. M. Juran
H. L. Dryden R. B. Smith

**ADVISORY MEMBERS OF THE COMMITTEE ON PUBLICATIONS:**

N. C. Ebaugh, Gainesville, Fla. Hunter R. Hughes, Jr., Dallas, Texas O. B. Schier, 2nd, New York, N. Y.
Junior Member: Joseph M. Sexton, New York, N. Y.

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price 75 cents a copy, $6.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters two weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4) . . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Copyrighted, 1946, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulations. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author, and that date of publication be stated.



*Glass-Forming Technique*

*(Operator "blows" bosses in high-frequency tube at the Brooklyn plant of Amperex Electronic Corporation.)*

# NUCLEAR ENERGY

## *Problems of the Engineer and the A.S.M.E. in Its Application for Beneficent Purposes*

By ALBERT L. BAKER

GENERAL MANAGER, THE KELLEX CORPORATION, NEW YORK, N. Y. MEMBER A.S.M.E.

THE announcement of the development of atomic energy has brought out, as might be expected, a wide variety of differing opinions on the subject. Included among these opinions are many expressions of pessimism regarding the future of civilization itself. It is my opinion that the engineer and the engineering society can and should concern itself with the field of nuclear energy and its beneficent application, but need not concern itself, particularly at this time, with the political aspects of the question, nor need they assume that the development of this particular science must result in the downfall of civilization.

### ATOMIC ENERGY, CIVILIZATION, AND ENGINEERING PROGRESS

Before discussing the problems of the engineer it seems advisable to examine the subject of atomic energy, and the state of civilization from the viewpoint of the engineer. The process of engineering has come to depend, to a large extent, on the expansion of knowledge in the fields of science, so that the engineer may continue to possess the opportunity to make additional useful applications. If we agree that engineering is the art of directing the forces of nature, for the service of man, we must also agree that the concomitant growth of civilization is an inseparable part of engineering progress. Progress in modern civilization has depended, and continues to depend, on investigators in the fields of science, on inventors, and on engineers. Research scientists and engineers have labored side by side for the betterment of civilization, not for its destruction, in the pursuit of security and a better life.

### GOVERNMENT-SPONSORED ATOMIC RESEARCH

The tremendous research and development program conducted by the Government on atomic energy during the war period has all been directed toward the production of atomic-bomb materials and the bomb which is a wholly military application (except for industrial blasting possibilities.) During the war military considerations could not and did not permit studies of useful application of this energy. The Manhattan District has announced the construction of the "Daniel's Pile" as the first peacetime successor to the bomb. This is to be the world's first chain-reaction power pile, enriched as to fissionable isotope, designed specifically to supply energy for an electric power plant. It is obvious from this announcement that the scientists and engineers are again resuming their normal roles, and civilization is advancing another step forward.

### DEVELOPMENT OF ENERGY

Obstacles have never prevented the development of any source of known energy forms. So long as potential-energy gain factors exist, their development for useful purposes will proceed, regardless of man-made barriers. The development and use of energy has been delayed by superstition, fear, politics, religion, stupidity, lack of basic education, or lack of communication. The delay, however, has always been temporary. An excellent index of civilization's progress is the utilization of energy per person in any area or country of the world. In the dawn of civilization the index was one man per man. In China today the index is less than 1.1 men per man. In the United States the figure is close to forty men per man. This index is based on available figures on power development from all sources.

### GAIN FACTORS

A convenient method of comparison of energy availability is through the use of gain factors. A gain factor may be defined as the gain in the energy controlled by one man through the use of a new invention, or the development of a new art. Thus when man learned to paddle a rude canoe he was able to propel himself across a river, but he also was able to carry in the canoe his family belongings and his family. He thus had a gain factor, through the use of the canoe and paddle, of two to three. Similarly, when he first used a sail he was able to transport several families and again achieved a gain factor of two to three.

In comparing the heat-energy release of present-day fuels, that is, coal and petroleum products, with an equal amount of nuclear "fuel" the gain factor is in the order of four million to one. This is a fantastic figure, when you consider the power industry that has been created in a relatively short span of years, with present low-grade fuels, the maximum gain factor for these fuels being in the order of two or three to one.

### MASS AND ENERGY EQUIVALENCE

It might be well to ask the question at this point—Why has this source of energy eluded science for such a long time? The equivalence of mass and energy was not stated until 1905, by Einstein, and only partially accepted some ten years ago. By 1930 the principle was accepted or proved for single nuclear transformation. By 1942 large-scale continuous conversion of mass into energy was achieved in the uranium chain reaction. The conversion observed in the phenomena of nuclear fission proved that mass and energy are two phases of a single thing. Science has been working, up to this time, on the outer electronic structure of the atom, in the field of very low-grade fuels. Nuclear fission makes it possible to enter the tiny central core of the atom and make use of the extremely high-grade energy contained therein. The changes in mass in ordinary combustion are too small to measure, but the mass conversion into energy in nuclear processes are large enough to be readily measured.

Nuclear "fuel" is used as a slang term to cover the active and inert material components in a nuclear-energy generator.

The beneficent application of nuclear energy opens up new vistas to creative minds, in an immense new field, which has been made available to the engineer in his conquest of work, time, and space. Some current articles dealing with nuclear

---

Address delivered at the Semi-Annual Meeting, Detroit, Mich., June 17–20, 1946, of The American Society of Mechanical Engineers.

energy refer to it as a remote future development. There are, of course, many problems which require hard work to solve. However, the controlled release of nuclear energy is an accomplished fact. It has been proved and in a variety of ways. The first pile operated in December of 1942, at Stagg Field in Chicago, at power levels of $^{1}/_{2}$ w to 200 w. Feeble though this was, it marked a tremendous step in man's progress because it demonstrated that the pile was a practical energy source. There followed the pile at the Argonne Laboratories in Chicago, where the power level was increased to the order of several hundred kw. Still another at Clinton Laboratories at Oak Ridge liberated 1800 kw, and finally, the three piles at Hanford, Washington, which operated with much larger outputs. The piles at Hanford were designed and operated to synthesize the new chemical element, plutonium, element 94. The heat liberated was incidental to the process.

The physicist accomplished his prime objective, in demonstrating the practicality of controlled release of nuclear energy. Thus the first and greatest barrier to progress in this field has been overcome. Nuclear fission does not require high temperature for its production, only bombardment of the nuclei in question by the elementary particle, or neutron. However, nuclear energy generator process systems designed to release controlled energy to do useful work must operate at high temperature levels for good efficiencies. This is the task to be undertaken by the engineer.

### FUTURE APPLICATIONS

It is possible at this time to foresee only a few of the ultimate applications which will be made of this new source of energy. The present position is comparable to that existing during the first few years after the discovery of the useful applications of steam, electricity, or the internal-combustion engine, except that the potential possibilities are much greater than in any of these fields. The most obvious applications are power sources for ship propulsion and central-station power plants. The efficiency of land plants may be increased by extending the radiation by-products for other industrial uses. In other cases the generation of power may become a by-product, and the main use of the nuclear energy generator will be the utilization of its intense radiation, the development of new fissionable materials, biological materials, as well as tracer materials for research, manufacturing control, and inspection of various processes. This opens up a new field to the radiochemists of the future.

Let us try to visualize the nuclear-energy electrical generating station of the future. The initial plants will utilize steam or gas turbines as the prime movers. In substituting nuclear "fuel" for coal, or oil, we no longer require the coal pile, coal handling or preparation equipment. The transport of fuel is virtually eliminated. Oxygen for combustion of the fuel, is not required. We can therefore eliminate the forced- and induced-draft fans, breechings, dust collectors, and stacks. We have eliminated, for all practical purposes, the boiler room as we now know it, together with the furnace, soot blower, and slagging problems, dust- and smoke-nuisance problems. In its place we substitute a nuclear energy generator process system, which consists of a nuclear energy generator and its component parts, including fluids for the transfer of heat and heat-exchanger equipment, all combined as an integral unit in a closed operating system. This applies to both the steam-turbine, and the gas-turbine cycles. The nuclear energy generator process system will be shielded in its entirety. The prime movers, whether gas or steam, including their auxiliaries, will require, comparatively, much less shielding.

Certain types of processing components, which must be considered an integral part of the nuclear fuel program, may or may not be located in the power station. These will be discussed later. However, in eliminating the noise of coal preparation equipment, flue dust, and stack-gas problems, we have introduced into the picture a plant that is as clean and quiet in operation as the average electrical substation. The controls for a plant of this type will, of necessity, be the remote-control type and therefore can be located at the main switchboard or control room, as you will. We might consider carrying the picture further and place all the controls in the operating engineer's office, and agree that we have arrived at the operator's "Utopian" power plant.

This new type of power plant will call for changes in the construction of plant facilities, all of which are in the direction of lower-cost construction. In addition to changed facility requirements, new personnel requirements will be introduced. The present central station requires laboratory control of feedwater and fuel which is taken care of by the station chemist and results-department specialists. Central-station boilers are operated by combustion operators and combustion control is maintained by combustion specialists. In a nuclear-energy generator steam plant the boiler-feedwater problem will still remain, because we have simply replaced the conventional steam generator with a heat exchanger. This problem is not present in the gas-turbine type of plant. The introduction of nuclear fuel will require a nuclear chemist, and a nuclear physicist familiar with fuel and inert-material component ratios, radiation, and instrumentation problems involved in the operation of a plant of this type.

### ENGINEERING PROBLEMS

We have glimpsed the Utopian plants of the future. Let us now examine the problems of the engineer with relation to the development of nuclear-energy generator process systems and processing components. In any program involving research and development for the industrial application of nuclear energy, there is a well-defined interrelationship between the problems involved in a process cycle, and its component parts. The relationship pertains to practically all aspects of research, development, engineering, and design fields. Progress in any one field is generally based on progress in related fields. Engineering materials of construction in use today are largely suitable, and can be used, in initial nuclear energy generator process systems. However, future progress to develop the full possibilities of nuclear energy will necessitate a large expenditure of time and effort in the development of materials for high temperature and radiation stability, shielding, and heat transfer.

The intrinsic nuclear energy temperatures available are in excess of millions of degrees, and are essentially infinite in so far as man is concerned. At the present time we are able to utilize engineering metals up to a temperature of about 2000 F and refractories up to 4000 F. The temperature level for operation of a nuclear energy generating unit will probably be limited only by the temperature to which the materials of construction and fuel components can be subjected. It is therefore apparent that the development of new metals and refractories for operation at higher temperatures than currently used in industrial practice will occupy a very important position in the program.

In considering materials for high temperature and pressure we are immediately faced with the problems of creep and strength diminution under long-time loading. A careful survey of the literature would indicate that many questions concerning creep design procedure, testing techniques, and interpretation of test data have not been satisfactorily solved, and must be regarded as controversial. It therefore appears that considerable work in this field will be required, with new test methods to be developed to cover testing of materials at high temperatures and under radiation at the same time.

Stability of the physical properties of materials subjected to intense neutron and gamma radiation introduces a new factor in the research program. Certain engineering metals suitable for high temperatures are subject to deterioration by fast neutron and gamma-ray bombardment, as well as other radiation effects. It will therefore be necessary to develop a series of engineering materials which are stable for each level of intensity of neutron and gamma radiation. This phase of the program opens up an entirely new and fertile field of research for the nuclear metallurgist.

Shielding is required for the protection of personnel, for neutron economy, and for conversion efficiency. The act of fission liberates fast and penetrating neutrons and at the same time releases radiations of tremendous penetration power. The neutron and gamma radiation due to reaction in the nuclear energy generator zone reaches an intensity in excess of a trillion times the amount that can be tolerated biologically by the human organism. For this reason the major weight and thickness of shielding material is required in this zone and may be classified as primary shielding. Shielding of the nuclear energy generator process system and processing components outside of the generator zone requires secondary shielding with considerable reduction in weight and bulk.

The principles of shielding are reasonably simple and depend essentially on the thickness and density of the protective material and the elements and isotopes thereof present. Although the radiation penetrating through shielding decreases exponentially with the thickness, it is obvious that the future development of nuclear energy for various applications requires considerable development in efficient shielding materials. If plants were designed for ship propulsion, the weight of shielding materials, bulk and arrangement of shielding devices must satisfy space, weight, and disposition limitations.

Improvements in shielding cannot be fully realized unless the program includes the development of neutron reflectors, neutron absorbers, adequate and safe alarm systems to indicate deterioration of shielding devices, as well as a means of determining the effectiveness of shielding design methods.

The future will probably develop three principal methods of use of nuclear energy: (*a*) as a heat source, (*b*) as electrical energy, and (*c*) through the use of direct radiation.

### HEAT-TRANSFER PROBLEMS

The utilization of nuclear energy on the basis of present knowledge does not include its direct conversion into usable energy nor as electrical energy. It is therefore apparent that various types of heat-transfer systems will be included in the nuclear energy generator process cycle. For maximum utilization the heat-transfer equipment should operate at higher flux densities than has been known heretofore in industrial practice. It will thus be desirable to develop improved heat-transfer systems and, as is obvious, these programs depend to a great extent on the progress of development work on metals and ceramic materials.

Appropriate fluids must be included in the heat-transfer systems, and serious investigation must be initiated to determine and develop the more perfect fluids adapted to meet special requirements of the different types of nuclear energy systems. One particular characteristic desired is a critical temperature well in excess of the metallurgucal limit. Other requirements should be fulfilled and may be classified as thermodynamic specifications of maximum, or idealized, requirements or goals.

This discussion would not be complete if the economics in the design of nuclear energy generators were not included. Central power stations designed for the generation of large blocks of electric energy do not burn the highest grade of fuel the market can provide. A boiler plant is designed to burn the grades of fuels from various mines that will generate a kilowatt hour for a maximum over-all economy for a given location. The efficiency of combustion is maintained as a continuous process cycle regardless of when a fuel change occurs. Nuclear energy generators must be designed on the same broad basic principle.

### NEUTRON ECONOMY, CONVERSION EFFICIENCY

The act of fission is a regenerative process and the important factors in this process are neutron economy and conversion efficiency. Neutron economy may be defined as the maximum, or idealized utilization of neutrons released for useful work. It might appear from the literature that this is a sort of hit-or-miss proposition, similar to a small boy throwing rocks at a bird. Let us agree that neutron economy is a definite engineering requirement of the first order in the design of any nuclear energy generator. The minimum neutron reproduction factor in any continuous nuclear energy generator process system must be equal to one. The average performance factor should exceed unity by a safe margin in order to meet the variable power demands of ship propulsion or central-station prime movers. Materials of construction used in the reaction zone must be such that they absorb neutrons at a rate well below the reproduction factor for any combination of active and inert materials. In any case all unavoidable losses must be kept to a minimum. Conversion efficiency may be defined as the conversion-factor requirement in design for the maximum utilization of low-grade, low-cost materials, such as U-238 synthesized into fissionable fuels.

Regardless of how efficient the regeneration characteristics of a nuclear-energy generator may be, a continuous supply of raw materials is still required. For this reason research scientists and nuclear physicists must continue their investigations to discover additional materials for use in these systems. This phase of the program must be considered an engineering requirement of the first order.

### PROCESS CYCLE AND PROCESSING SYSTEMS

Numerous process cycles and processing systems will be invented, engineered, and checked as to characteristics and suitability, for use with materials and shielding systems developed. It is emphasized, however, that while these inventions are a major part of the work, they still are of secondary importance as compared with material requirements, shielding, and heat-transfer problems, in obtaining maximum utilization and optimum operating characteristics of nuclear fuels in the design of the various process-system applications.

In addition to the development of nuclear energy generator process systems, processing systems, and fuel-processing plants must be considered an interrelated part of the program. The application of nuclear energy for various process systems requires satisfactory solutions to problems involved in processing systems associated with the nuclear energy generator unit.

Processing plants will be required for the treatment of both raw and fissionable materials before and after being used in the generator system. As a result of fission, new synthesized elements will be developed and changes will occur in fissionable materials. Fission products are the "ashes" from nuclear energy generators. These by-products, which are both solids and gases, must be removed periodically, or as a continuous process, in order to avoid serious loss of efficiency in the operation of the unit. The processing systems required for the various operations may be classified as follows:

1 Processing preparation of nuclear fuels, active and inert material components.

2 Processing storage.

3 Processing fuel-feed systems.

4 Continuous process control, fuel and inert-material com-

ponent ratios, in operating nuclear energy generator systems.

5 Processing disposal systems for gaseous, liquid, and solid reaction products.

6 Reprocessing systems for ash and partially spent fuels.

7 Mobile and stationary processing plants.

Word has just been received of the release of some of the knowledge of nuclear physics acquired during the war on the Manhattan Project. The first series of papers was presented at the 272nd meeting of The American Physical Society held at Chicago June 20 to 22, 1946.

On Thursday, June, 20, 1946, Messrs. Fermi, Christy, and Breit spoke on topics of extreme interest, their subjects being, respectively, "Elementary Pile Theory," "The Small Enriched Reactor at Los Alamos," and "Theory of Nuclear Reactions." On Friday morning this sequence of notable invited papers was continued by Messrs. Daniels speaking on "Problems and Plans of Nucleonics Research," Dunning on "Neutron Spectroscopy," and Goldsmith giving "A Critical Survey of Neutron Cross Sections." On Thursday evening after the dinner, A. H. Compton spoke on "Physics Research and Release of Nuclear Energy." An address by G. T. Seaborg, "The Transuranium Elements," was scheduled for Saturday afternoon.

These papers constitute the first release of matter formally classified but now officially declassified and released for public use. Much of the formal data required for nuclear energy generator design is containd in these papers.

### A.S.M.E. NUCLEAR CODES

The American Society of Mechanical Engineers has the problem of planning, organizing, and executing codes as a guide in the successful development of nuclear energy. The engineering profession has achieved its present position by steadily widening the structure of engineering. Experience has proved that certain phases of engineering applications and maintenance of standards cannot be handled on a merely voluntary basis. It has therefore been necessary to establish safety codes and standards as a protection to the public and in the interest of engineering progress. The handling and use of radioactive substances involves hazards in which the public must be educated in order that the loss of lives through carelessness, or negligence, may be reduced to a minimum. The immediate development of safety codes becomes therefore a prime requisite on the part of the A.S.M.E. The extension of other codes, standards, and test procedures are also required, and may be summarized as follows:

1 Safety codes for construction and operation: (*a*) Covering biological hazards; (*b*) covering chemical hazards; and (*c*) covering physical hazards.

2 Standardization of definitions, constants, units, symbols.

3 Standard specifications for materials of construction: (*a*) Under pressure and stable as to radiation effects; (*b*) under temperature and stable as to radiation effects; (*c*) used for shielding and stable as to radiation effects.

4 Test procedure for materials: (*a*) For physical properties; (*b*) for radiation stability; and (*c*) for shielding stability.

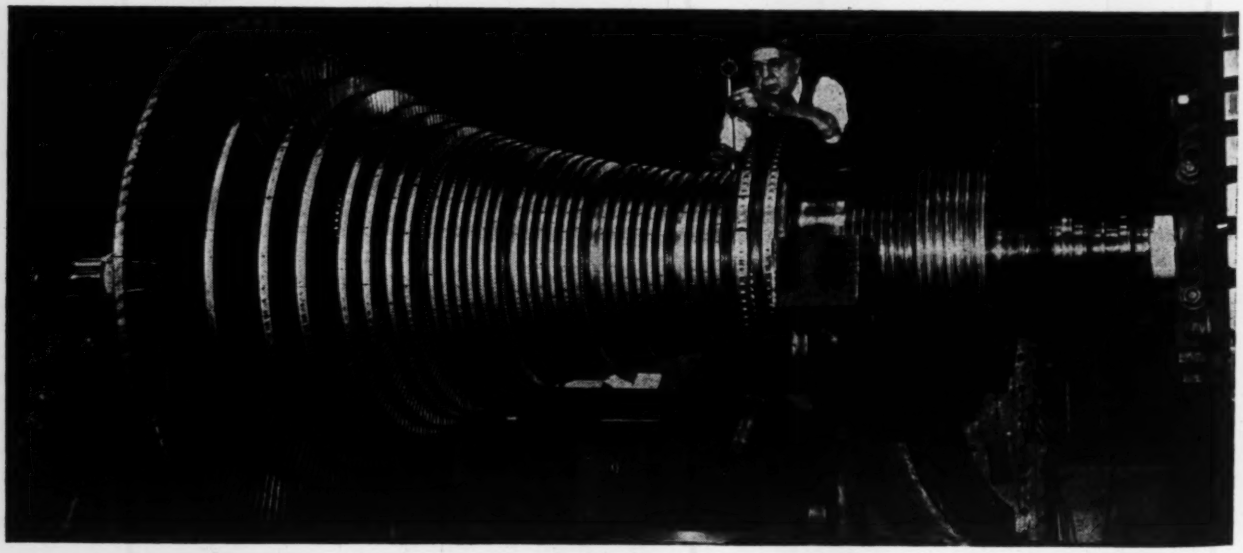
5 Power test codes: (*a*) For nuclear energy generators; (*b*) for nuclear energy generator process systems; and (*c*) for nuclear energy processing systems.

All theory should be reduced to practice before setting up other than tentative codes. The codes should be based on actual data acquired by the engineer. They should be so set up as to assure safe development of the industry without burdening it with unnecessary restrictions of an impractical nature. The various standard codes in effect today are fluid, undergoing continual change, to keep abreast of progress. Codes for nuclear energy must be organized on the same fundamental principle.

### CONCLUSION

"Keen powers of observation, fertility in inferences, initiative, resourcefulness, courage, and a full sense of human relationship are qualities that have made great engineers." Let us continue to develop these qualities in carrying out the task before us in the application of nuclear energy for beneficent purposes.

Those of us who have been fortunate enough to participate in the Manhattan District Project have been amazed and gratified at the substantial success of our co-ordinated efforts. We are very humble, however, in our thinking and know definitely that we know little about this great new field. We, as engineers, are also convinced that the physicists have progressed to a point where an enormous field of engineering work can be exploited and should be exploited now.



CHECKING FOR SIZE

(Mounted in huge lathe in Westinghouse Electric Corporation's South Philadelphia plant, this 20,000 kw steam-turbine spindle is being checked for size to prevent steam leakage and to assure peak efficiency.)

# NUCLEAR ENERGY *as a* POWER SOURCE

## *United States Navy's Interest in Nuclear Power as Distinct From Use in Nuclear Ordnance*

By REAR ADMIRAL H. G. BOWEN, U.S.N.

CHIEF OF THE OFFICE OF RESEARCH AND INVENTIONS, UNITED STATES NAVY

ALTHOUGH the ultimate development in the field of atomic energy must come under the general guidance of a Civilian Atomic Energy Commission, the Navy recognizes six aspects of this field in which it has responsibilities. These are as follows:

1 The maintenance of a vigorous program for the propulsion of ships, submarines, and aircraft by nuclear energy.

2 The development of nuclear munitions, and the vehicles to launch and carry them.

3 The utilization of nuclear studies for the medical sciences.

4 The exhaustive exploration of all possible countermeasures to nuclear munitions and their carriers.

5 The maintenance of a broad program of research in nuclear physics and the allied fields of science.

6 The education and training of naval personnel in nuclear energy and its applications.

It seems to me that the horror of the atomic bomb has blinded many minds to these other possibilities of atomic energy and in particular, atomic power. With this in mind, it will be of value to consider the possibilities of naval utilization of atomic power completely apart from the ordnance use.

### HISTORY OF POWER DEVELOPMENT

The development of power was, of course, the cause of the industrial revolution. The development of civilization was always held back by the lack of power, and the pages of history are studded with instances of the attempts of many men to remedy this situation.

The industrial revolution or the revolution in power really started when James Watt put a condenser on the ordinary reciprocating pumping engine, which was so widely used at that time in England, France, and other countries in order to free mines of water accumulations.

The next stop was to put this engine into ships and into locomotives. The Navy began mechanizing in 1837 and the *Fulton II* represented the first regular Navy vessel with steam machinery.

For years afterward the largest steam installations were afloat, and the navies and merchant marines of the world pioneered in steam engineering and power. In 1882 an event took place which was to have a profound effect on marine engineering and steam power in general. Thomas A. Edison in that year established the first central steam-power plant in the United States at Pearl Street in New York City, producing direct current.

It was not long after this that George Westinghouse introduced alternating-current machinery. The development of the central power plant of the light and power industry had ultimately a great effect on our Navy. It meant that the Navy was to share leadership in the development of power.

In 1933 we started rebuilding the Navy, and went to the central power plant and the manufacturing industry for inspiration and guidance. In central-power-plant practice pressures and temperatures had risen far above those used in naval vessels. The engineers, turbine makers, boiler builders, and contributors of auxiliaries had really done a wonderful job and made the central power plant of the light and power industry the finest in the world. There are, of course, intrinsic differences between power-plant designs and marine-engine designs. Space and weight matter very little to the power-plant designer, or at least much less than they do to the marine engineer. On the other hand, the marine engineer employs higher turbine speeds and reduction gears.

The manufacturers of central-station equipment are in many cases the manufacturers of the machinery for naval vessels. This is true whether it involves turbines, boilers, heat-transfer apparatus, or auxiliaries.

As a result of this incorporation of the latest ideas from industry, by the time of Pearl Harbor the Navy had completely redesigned, proved at sea, and standardized all of its machinery for both surface ships and submarines.

This period from 1933 to 1940 was one of the most important periods through which engineering in this country ever passed. It marked the end of the ship and engine builder. From then on shipyards became assembly plants which were particularly characteristic of this war in the production of merchant shipping. It marked the pre-eminence of the United States in all forms of engineering.

### EFFECT OF WAR ON NAVAL MACHINERY IMPROVEMENTS

The machinery used in the war program was the result of millions of dollars spent on research and development over the years by the builders of turbines, reduction gears, electrical machinery, boilers, cables, Diesel engines, and many other machinery items.

A large percentage of all operations during the war were at high speeds, and the increased fuel economy attained was of great assistance in the long reaches of the Pacific. Unbelievable mileages without repair were the rule rather than the exception. The machinery proved to be as rugged and reliable as its proponents had prophesied, and the amount of repairs required by ships during the war was unbelievably small. Our machinery, whether we consider surface ships or submarines, was proved in war to be far superior to that of any other navy. Horsepower and not the biggest battalions won the war.

---

Address delivered at the Semi-Annual Meeting, Detroit, Mich., June 17–20, 1946, of The American Society of Mechanical Engineers.

We have with us today, and we will have to a much greater extent in the future, gas turbines, turbojets, intermittent jets, and ram jets. But the great advance of the future is atomic power and, in so far as the Navy is concerned, the effect of the transition from oil burning to atomic power will be as revolutionary as from sail to steam.

I would like you to know that the Navy has not suddenly become interested in the possibility of atomic power quite to the contrary. The Navy in 1939, at the Naval Research Laboratory, was the first and for some time the only government agency which was actually working on some of these problems leading to the development of the atomic bomb and the possibility of atomic power. The discovery of uranium fission and a preliminary understanding of its implications were announced in the United States about January 26, 1939.

### THE NAVY BECOMES INTERESTED IN NUCLEAR POWER

In a conference at the Navy Department on March 17, 1939, two outstanding physicists, Drs. Enrico Fermi and G. B. Pegram, urged Navy consideration of the utilization of uranium for power purposes. Dr. Ross Gunn of the Naval Research Laboratory and other representatives of the Navy attended this conference. Three days later Dr. Gunn reported to me in my office in the Navy Department that he now believed there was a possibility of obtaining energy from the atom.

Since the Naval Research Laboratory at that time was under the Bureau of Engineering, I told Gunn to go ahead and let me know what funds were required. I gave him the allotment of $2000 he requested, which seems like a ridiculously small sum today when we are accustomed to thinking in terms of billions. But the truth of the matter is that one cannot expend enormous sums at the beginning of the development of a new art. It takes time for the scientists to make their plans and for the project to fan out into the large-scale activities which are characteristic of later developments when much more is known of the subject.

The first step appeared at that time to be the production of large amounts of uranium-hexafluoride, and subsequent advances have shown this evaluation to be correct. This chemical compound was the simplest and most stable known form of uranium that occurred in the gaseous state under normal conditions. Its production on a large scale was indicated even then. Using the first $2000 allotted by the Bureau of Engineering, R. R. Miller of the Chemistry Division, Naval Research Laboratory, working with Dr. T. D. O'Brien who was specially hired from the University of Maryland for this work, undertook the production of modest amounts of the key chemical, uranium-hexafluoride. The first method employed metallic uranium which was pyrophoric and was unnecessarily dangerous and expensive in production. Small amounts were produced, however, and 9 months later, January 10, 1940, the Laboratory supplied gram-size samples to the University of Virginia and the University of Minnesota for use in preliminary isotope separation work.

As early as June 1, 1939, the Laboratory had submitted a memorandum on the use of atomic power for driving submarines. In 1940 the Laboratory entered into contracts with the Carnegie Institution of Washington, the University of Virginia, and Columbia University for the purpose of getting a power program started involving the production of material suitable to operate a chain-reacting nuclear pile. Close liaison was maintained with Prof. A. O. Nier of the University of Minnesota, who made many of the early isotope measurements without payment. Thirteen thousand dollars was allotted to the University of Virginia to carry on the early phases of isotope separation by use of high-speed centrifuges. Dr. Jesse Beams was a world authority on such high-speed devices, and through co-operation with him, the Laboratory, as early as February, 1940, had a fraction of a gram of moderately enriched uranium 235 isotope. Simultaneously, $30,000 was assigned to Columbia University for the study of centrifugal fractionating columns, also for isotope separation. In addition to this, the Naval Research Laboratory bought, for the use of the Columbia group, 1 g of radium which they mixed with beryllium in such a way as to provide a powerful neutron source. This powerful neutron source was of use to the Columbia group in their early study of pile performance using ordinary uranium and graphite.

In addition to the allotments mentioned $2500 was finally assigned to the Carnegie Institution of Washington, to help support the liquid thermal-diffusion method of isotope separation. The early costs of this investigation were borne wholly by the Carnegie Institution as a public service.

Beginning in January, 1941, Dr. Philip H. Abelson joined the Laboratory from the Carnegie Institution. Recognizing the inadequacy of the methods then employed for the production of uranium-hexafluoride, he succeeded in working out a greatly improved method which has been widely used. The production phases of this improved method were sufficiently developed by December 1, 1941, so that large-scale production was possible. Other producers were given full information at later dates.

A small pilot plant was immediately built and operated at the Laboratory and by November 15, 1942, the Laboratory had ten to fifteen columns set up and operating in a satisfactory manner. By June, 1944, a large production plant at Philadelphia was nearly completed. About this time the Manhattan Project decided to go ahead with a similar production plant at Oak Ridge. Dr. Philip H. Abelson and other research scientists from the Naval Research Laboratory were assigned to the project at this time to act as supervisors in the erection of the plant. The Naval Research Laboratory also trained operators for this plant.

Thus you will see that the Navy early appreciated the role which atomic energy was to play in the field of power. While great and successful progress was made in producing the atomic bomb, until recently atomic power was sidetracked in favor of atomic munitions.

### SOURCES OF POWER IN THE UNITED STATES

May I digress for a moment to emphasize the amount of power available to each citizen of the United States. We have in the light and power industry, for example, 70,000,000 hp. The Navy, which together with the light and power industry has led the world in the development of power, has added 70,000,000 hp to its fleet during the war. The railroad industry has an installation of 100,000,000 horsepower, steam and Diesel. And finally, we come to the great American epic, the flivver or the custom-built, according to how one is economically situated. Under the hoods of the private automobiles, trucks, and buses of the United States is a capacity of 2,400,000,000 hp. This brings the total for the United States, on the basis of capacity, and I believe this is an underestimate, to 2,640,000,000.

It has been said that the civilization of Athens, in some respects a civilization that has never been surpassed, depended on ten slaves per free man. Today we have over 20 horsepower at the disposal of the average individual of the United States, so that by this gage alone we can measure the extent of our material prosperity compared with other nations. As a rule, the enormous horsepower available to each one of us directly or indirectly is taken for granted and is not the source of any comment.

The Navy is not only the greatest single user of power, it is also the largest single technical organization in the world. In the Bureau of Ships are many highly trained and competent power engineers who are available to develop and perfect atomic power. We would expect to do this in collaboration with the light and power industry and those manufacturing corporations who are designers and purveyors of equipment for both institutions just as we did in the case of our present marine power plants. The ultimate competition between ordinary fuels and atomic energy as a source of power will depend on economic considerations. The use of atomic power for war vessels is justified now from military considerations. Its use in the merchant marine, whose vessels must carry huge loads of heavy fuel, will result in its economical use there, before it will be justified for use in central power plants. Eventually, however, atomic power has tremendous possibilities in the light and power industry. Nevertheless, we believe the development of atomic power for naval vessels offers the very best opportunity to expedite its economical use by industry.

There will be no miraculous transformation of atomic energy into power. The heat from atomic fission will be used to make steam, and steam will drive turbines or reciprocating engines exactly as it does now.

If we start with a large naval vessel we will find that the elimination of the boilers and associated auxiliaries, as well as thousands of tons of fuel oil, offers the possibility of more advantageously disposing of weight. The whole hull structure can be materially strengthened, and armor can be more generally used, all with the idea of making ships less vulnerable to attack by atomic or other forms of bombing. Since economy of fuel will no longer be essential, turbines will be completely redesigned with the single purpose of increasing the amount of horsepower per pound of turbine. With resulting speeds greatly increased there will follow a complete redesign of the underwater body. Marked increases in speed will reduce the possibility of effective bombings, etc. We will be searching for an ideal coolant for the atomic pile which will be fluid from room temperature to 1500 or 2000 F and which will not become radioactive to any troublesome extent. The design of the necessary heat exchangers will furnish a fascinating problem to those in that field.

Owing to the weight of the pile, it is obvious that until the scientists have augmented our present discoveries, atomic power will not be available to displace internal-combustion engines in private automobiles, trucks, buses, and aircraft. As a matter of fact, the only function which aircraft has in this atomic era at present is the delivery of atomic bombs to the target. Even this transportation by the airplane will probably be superseded eventually by that afforded by guided missiles.

### EFFECT ON EVOLUTION OF SUBMARINE

However, even with the present weight of the pile, its installation in a submarine makes a very attractive proposition. Since oxygen or oxygen-bearing fuels will no longer be required, we will be able to realize submerged speeds and submerged radii of action which will put the submarine in a distinct class as a major combatant unit. Its development into a much larger vessel, capable of carrying out many missions successfully, is clearly indicated.

It is commonly said that we may not expect an atomic pile to weigh less than 100 tons, depending upon the temperatures used. The present weights of power plants in large naval vessels far exceed this amount. We would expect to see marked improvement in pile performance concurrent with the great advances in engineering which are required.

It is obvious that the advent of atomic power will in time greatly affect such matters as tanker supply and fleetbases.

The ship powered by atomic energy will have a cruising radius dictated only by the quantity of provisions which can be carried. Recent developments in bottom paints during the war render the question of periodic dry-docking a relatively unimportant matter.

### URANIUM NOT THE ONLY SOURCE OF ATOMIC FUELS

In developing atomic power, it must be recognized that uranium and plutonium do not constitute the only atomic fuels. Security permits me now to discuss the possibility of supplementing the available uranium resources by substituting thorium in the atomic pile. It has been shown that thorium will undergo fission and may be "burned" in the chain reaction just as uranium now is burned. Another radical departure from present atomic-pile design may result from the increasing availability of other transuranic elements such as the newly discovered americium and curium. These elements can be expected to undergo fission more readily than the previously mentioned fuels. Herein lies another opportunity for decrease in pile size which will increase the engineering difficulty of heat transfer and removal.

To date the possible atomic fuels have been considered to include only fissionable materials. However, it has been shown that the same tremendous energy release accompanies the fusion of certain light elements. Fusion can best be described as the combining of two light nuclei to form a heavier one, that is, the opposite of fission. It is interesting to speculate on the possibility of using such a cheap element as hydrogen as the atomic fuel of the future.

The Navy expects to undertake and promote such work in the atomic field in collaboration with the work of other federal agencies in whose programs the Navy claims the right to participate on the basis of equality. Above all, the Navy recognizes its traditional responsibility to consider the changes in the world's social structure and their implications for our national security resulting from nuclear energy and munitions.

### NAVY SUPPORTING BASIC RESEARCH IN NUCLEAR PHYSICS

The Navy's Office of Research and Inventions is proceeding with contractual relations in basic research with many of the important centers of learning in the United States. The nuclear physics contracts are part of the program and share the same broad approach to the acquisition of knowledge which characterizes other parts of our program.

The contracts for basic research are free from the troublesome task of security classification and no inhibitions are placed upon the publication of scientific articles.

The letting of basic research contracts is obviously a new departure for a government agency, but it seems evident that this is the best means, if not the only means, of performing this vital and necessary liaison between the Navy and science.

Under the Atomic Commission, consistent with any international arrangements, and within the sphere of naval uses, the Navy hopes to take the lead in the development of atomic power. To do otherwise would be to neglect our duty grossly and to fail in discharging our responsibilities to our country. This development of power should proceed as rapidly as possible. In case of another world conflict our chief hope of survival would be that industry be placed on an atomic-power basis just as rapidly as possible. The Navy's vigorous pursuance of atomic power will contribute materially to this coversion in industry.

This discussion has been confined to one aspect only of naval development—namely, atomic power. No one can predict how our Navy will appear 10 years from now. However, we shall make every effort to produce, as rapidly as possible, a Navy in which full consideration has been given to all possibilities, such as, jet propulsion, gas turbines, guided missiles, pilotless aircraft, and atomic power.

# *Effect of McMahon Bill on* NUCLEAR-ENERGY APPLICATION

### By SENATOR BRIEN McMAHON

CHAIRMAN, SENATE SPECIAL COMMITTEE ON ATOMIC ENERGY

I HAVE been asked to speak to you today on "The Effect of the McMahon Bill on Nuclear Energy Application." I shall be glad to tell you what I can about the McMahon Bill, since I have some small familiarity with it—and perhaps even a somewhat fatherly affection for it. Those of you who are parents know how easy it is for a proud father to become a plain bore when he's talking about his offspring. I don't want to bore you, and so I'm going to talk about my brainchild only part of the time I am with you. I trust you will forgive me if I briefly extend my remarks into a broader field and say a few words also about the function of the engineer in the atomic age. Of course, any ideas I may have along that line must necessarily be those of a layman. I can hardly be called an engineer, unless, of course, one is willing to say that the planning, designing, and producing of legislation is a form of social engineering. If, under that definition, you are willing to accept me into your fraternity, then I should, perhaps, address you as brother engineers.

At any rate I know I feel most friendly toward this organization, and toward engineers in general. At a time when the struggle for a policy of civilian control over the development and use of atomic energy was at its highest pitch, when I found myself standing alone against the other ten members of my Committee, men whose judgment I respected and whose loyalty was unquestioned—it was at that time, that I received at my office in Washington a 327 word telegram which gave me strength and courage and helped me carry on the fight to eventual victory.

That telegram said in part: "The undersigned address you as individuals who believe that the greatest possible advantage should accrue to the public welfare from the use of nuclear energy. We know of the destructive use of nuclear energy, but our interest is in its greater use for public good. We agree in general with the provisions of your Senate Bill 1717 as heretofore published. We believe that the Federal administration of all matters dealing with materials fissionable by chain reaction should be in the hands of agencies that are essentially civilian in make-up. We believe that the Federal Government has a responsibility for the safe use of these materials. We believe that the greatest advantage from the use of these materials will be for civilian industrial purposes . . . . . We appreciate the tremendous responsibility you have undertaken in stating a policy for this nation to follow in dealing with this new source of useful energy."

That telegram was signed by W. W. Horner, president of the American Society of Civil Engineers; William E. Wickenden, president of the American Institute of Electrical Engineers; James G. Vail, president of the American Institute of Chemical Engineers; and by your president, D. Robert Yarnall, president of The American Society of Mechanical Engineers. I don't know how much that 327 word telegram cost your treasury but I hope you feel you got your money's worth.

I am sure that the McMahon Bill is too familiar to all of you to need complete recapitulation here. I will therefore mention only those portions of it which have special interest for you as engineers, and discuss their effect on nuclear-energy application.

As you know, the bill establishes an Atomic Energy Commission of five civilian administrators to direct four divisions: Military Application, Research, Production, and Engineering.

#### DIVISION OF ENGINEERING

To engineers must go considerable credit for the inclusion of a Division of Engineering, as one of the divisions under the Atomic Energy Commission. As originally set up in the bill these Divisions were Military Application, Research, Production, and Materials. However, August C. Klein, engineering manager for the Stone & Webster Engineering Corporation who had been project engineer in the design and construction of the electromagnetic plant at Oak Ridge, came to Washington and testified at a committee hearing. As a result, a Division of Engineering was substituted for the Division of Materials. "There should be a Division of Engineering," he told us, "headed by an administrative engineer experienced in the field of design and construction and having a thorough knowledge of the industrial fabric of the country and of the possibilities and limitations of production-line manufacture of equipment."

The Engineering Division, he pointed out, could play an important part in determining plant investment costs and operating savings. It could explore and report on the ability of industry to furnish any new equipment required and would prepare time schedules of the work involved. Upon the approval of any project, the Division of Engineering could supervise the design and construction of the plants, including procurement of equipment.

#### GOVERNMENT MONOPOLY

The Atomic Energy Commission is required to maintain an exclusive government monopoly of facilities for the production of fissionable material. Provision is made for the operation of such facilities under management contract when it is deemed desirable. Private ownership is expressly forbidden except for facilities producing small amounts incident to research and insufficient for making an atomic bomb.

While such a government monopoly may seem like a step toward socialization of industry, the Senate Atomic Energy Committee (which included some of the most conservative men in the Senate) agreed unanimously that during the present stage of world affairs it would be unthinkable to permit private vested interests to own or control facilities for the production of atomic weapons. The Committee agreed that private ownership of production facilities at this time would greatly and unnecessarily increase the difficulties of obtaining and enforcing international agreements which are now needed so desperately for the maintenance of peace and the prevention of an atomic war. It was felt that government monopoly is the only means of assuring the national security and the general welfare through

---

Address delivered at the Semi-Annual Meeting, Detroit, Mich., June 17–20, 1946, of The American Society of Mechanical Engineers.

programs of full-scale research, development, and application of nuclear energy in all possible fields.

As men interested in civilian industrial uses of fissionable material and its by-products, you may reasonably ask whether such a government monopoly as is here set up will not discourage full-scale development and application. The answer is quite to the contrary. I believe it will encourage and stimulate such uses. You will note that the Commission is "directed to distribute sufficient fissionable material to permit the conduct of widespread independent research and development activity, to the maximum extent practicable." The Commission is authorized to distribute fissionable material, with or without charge, to applicants requesting such material for three purposes: (1) For the conduct of research or development activities either independently, or under contract or other arrangement with the Commission; (2) for use in medical therapy; and (3) for use pursuant to a license issued for utilization in an atomic-energy device.

The Commission will also distribute *by-product* materials with or without charge, for research and development activities, medical therapy, industrial uses or other useful applications, priority being given to research and medical uses.

Above and beyond all this, the Commission is directed (and I want you to note that word "directed") to insure continued research and development, not only through its own facilities, but by private or public institutions or persons through contract arrangements, loans, and grants in aid. In view of all this I think you need have no fear that research and development activities will be discouraged or stifled.

### PATENTS

Engineering is primarily the art of applying the resources of materials and power in nature to the use and convenience of man. The engineer takes the discoveries of scientists and translates them into processes, structures, and machines. That being the case we may expect many of the new processes and devices utilizing nuclear energy to come from men in this room or at least from men in your profession. Your interest in the patent provisions of the McMahon Bill is therefore to be expected.

Section 11 of the bill provides that patents may be issued for all types of discoveries or inventions except where it is useful solely for the production of fissionable materials, or solely for the utilization of fissionable materials or atomic energy for military weapons. In such cases the Commission is authorized to make just compensation to the inventor in lieu of a patent. In cases where an invention has a dual purpose, one being military and the other nonmilitary, a patent may be issued for its nonmilitary use but not for its purely military use.

While the provisions concerning patents are necessarily rigid because of the importance of atomic energy to national defense and public welfare, an attempt has been made to counterbalance this rigidity with liberal compensations, awards, and royalties to be determined by a special Patent Compensation Board.

### FREEDOM OF RESEARCH

Scientific discoveries are the raw material of human progress and as men who put scientific discoveries to work for the benefit of mankind you are naturally interested in the preservation of freedom of research and discovery. The very lifeblood of scientific progress is the flow of ideas that comes from the clash of theories and practices. America's industrial pre-eminence does not rest on secrets locked in a strongbox but on our resourcefulness in translating ideas from the laboratories of the world into practical processes. The welfare of our people and our national defense is based on scientific and industrial advancement.

Does the McMahon Bill hinder such advancement by locking all our information in a strongbox, preventing the exchange of information and ideas, and by putting blinders and ear muffs on our scientists and engineers? No, it does not. But does it give us security by protecting such secrets as we may have which are of military value? Yes, it does. The McMahon Bill gives us both scientific progress and military security by a painfully achieved formula which provides for security by achievement, rather than security by concealment.

I say that the formula was painfully achieved because, frankly, it was one of the most difficult problems we faced in the Committee. The problem was eventually solved by Section 10 of the bill which establishes certain categories of information which are designated as "restricted data." Severe penalties are provided for transmitting or receiving such data with intent to injure the United States or give advantage to a foreign power, or with reason to believe that such will be the consequences. From the field of restricted data the Commission is authorized to withdraw, from time to time, such data as it determines may be safely published without adversely affecting the common defense and security.

In this way, you see, the outside limits of the crime have been affirmatively established, placing everyone on notice as to what kinds of information are classified. It is then a simple matter to find out whether any particular piece of information has or has not been withdrawn from the restricted category. The Commission is established as the top authority with reference to restricted data and it has power only to reduce the scope of the crime—not to enlarge it.

### LICENSING

I know that, as mechanical engineers, you are especially interested in the industrial utilization of nuclear energy. Well, let's see what the bill provides on that score. Section 7 of the bill provides that the manufacture of equipment or devices utilizing fissionable material or atomic energy is subject to licensing by the Commission. However, no such license may be issued until Congress has had a period of 90 days in which to consider a report on the social, political, economic, and international effects of the use of such a device, and to provide supplementary legislation if desirable.

If Congress permits the 90 days to pass without taking any action, then the Commission may issue licenses, for periods of one year or less to all applicants who can meet safety and security standards. It is expressly provided that in no case shall these licensing provisions be used to "maintain or to foster the growth of monopoly, restraint of trade, unlawful competition, or other trade position inimical to the entry of new freely competitive enterprises in the field."

It is also provided that power produced as a by-product of the production of fissionable material, may be used by the Commission, transferred to other government agencies, or sold to public or private utilities under contracts providing for reasonable resale prices.

In framing these licensing provisions, it was the intent of the Committee to enable the Commission and the Congress to control the development and utilization of atomic energy with some reference to the profound effects it may have on our economic system and on the then existing international political situation.

Let me explain what I mean in more concrete terms. Suppose one of you men invented a device by means of which it became possible to utilize atomic energy as a very inexpensive but high-grade and low-weight fuel, much better than gasoline. Such a utilization, if permitted to appear on the market overnight, without any controls, might wreck the petroleum industry in one blow, throw thousands of men out of work and cause the loss of millions of dollars of investor money. If this were permitted to occur in many industries the effect would be chaos and misery. Such disastrous results might turn the people of the world against the Atomic Age, just as the resulting technological unemployment turned the home-industry workers of England against the Industrial Revolution. Of course, you and I know that the Atomic Age is here to stay. The widespread utilization of nuclear-energy devices for peaceful industrial purposes is inevitable. The question is, shall it come about in an orderly and evolutionary manner, one which will substitute new industries as the old ones become obsolete, one which will provide new jobs as the old jobs are done away with? Or shall it come about in an uncontrolled, chaotic, and revolutionary manner?

The intent of the McMahon Bill is not to restrict or retard development or utilization; its purpose is to bring about development and utilization, to give the people who invested billions of dollars in this project the dividend on their investment, but to do it in a manner which will make it a blessing, rather than a curse because of needless suffering and misery. The unlocking of the atom was a revolution. There can be no dispute about that. Now, we must do something new in human history. We must police a revolution for the protection of the people.

I believe that I have touched on all the provisions of the Atomic Energy Bill which appear to be of special interest to you as engineers and, if you will bear with me for just a few minutes more, I would like to say a few words about the engineer in the Atomic Age.

### THE ENGINEER IN THE ATOMIC AGE

While the contribution of the scientist to the development of atomic energy has everywhere been recognized, the work which the engineers performed is, I am sure, not so well known among the general public. Without detracting one iota of credit from the scientists, who richly deserve great honors, I should like to point out that there is a considerable difference between making an experiment work in a laboratory or on paper and making it work under actual conditions of production.

August Klein ably pointed out to our Committee the differences between laboratory-scale experiments and full-scale plant operation. The scientist's experiments are completed within a period of a few hours or a few days and his apparatus can be constructed to have a very limited life. The engineer, on the other hand, must design and construct plants which will operate continuously for months or years. The scientist is able to draw on the most highly skilled personnel to do his work, but the engineer must provide apparatus capable of being used by workers of average intelligence and education. This calls for the development of intricate automatic-control equipment. The scientist performs his experiments on a single piece of apparatus but the engineer must design equipment to multiply these operations manyfold. The scientist is not necessarily concerned with the factors of time and cost but the engineer is always concerned with them.

I doubt if it is generally realized that without the engineers we would not have had the atomic bomb. I doubt if it is generally known that several thousand engineers were associated in the building and functioning of the Manhattan Engineering District. The successful explosion of the first atomic bomb in the desert of New Mexico was a monument to the knowledge of the scientist who unlocked the secrets of the atom and suggested the basic technique of making plutonium and concentrating U-235 but it was equally a monument to the technical skill of the engineers who built the bomb. It has been estimated that the job was at least 50 per cent engineering. The various big plants of the Manhattan Project are vast assemblages of pipes, tanks, boilers, valves, instruments, and controls. They were largely designed by engineers and wholly installed and operated by engineers.

The combination of scientist and engineer which brought us such unparalleled success in wartime, can carry us to greater achievements in peacetime. Just as in baseball it would be bad judgment to break up a winning pitcher-catcher combination, just so it is necessary to maintain and even extend the teamwork of the researcher and applier. Dealing in research, the scientist discovers all sorts of facts about the world we live in and the universe beyond. Sometimes these discoveries lie dormant for years, or even for centuries. Sooner or later the engineer comes along and puts these discoveries to practical use for the benefit of man. The discoveries of science, when developed and harnessed by the engineer, have brought about new ways of life and higher standards of living. They have helped to make it possible for men to be free, to a greater degree than ever before in history, from the evils of slavery, poverty, drudgery, and insecurity.

Now the scientists have given us a new discovery—nuclear energy. Dr. Karl Compton has pointed out that "energy is wealth." The wealth level of mankind is determined by its development, control, and use of energy. The greatest energy, the basic energy, is now waiting for development. The people of the world are waiting for its use. They do not want this energy to destroy them; they want it to enrich them. In that enrichment you, Mr. Engineer, will play a vital role. The Atomic Age is waiting for you.

## Deicing Aircraft Windshields

ELIMINATION of aircraft windshield icing and interior fogging through use of a development of glass research has been revealed by the Pittsburgh Plate Glass Company.

Commercially known as Nesa, the idea involves the use of a permanent transparent coating for glass that successfully conducts electrical current over the glass panel. William O. Lytle, member A.S.M.E., research engineer at the company's Creighton Research Laboratories, is credited with the development of Nesa.

It is claimed that application of the new coating to glass makes it possible to heat the entire area of the panel by a uniform flow of electrical current across the glass surface.

Exhaustive tests at the glass company's research laboratories fail to show distortion of vision through the treated glass. No material reduction in the intensity of light transmission through the coating is apparent.

In addition to the deicing and defogging characteristics, another of the advantages claimed for this coated glass is that it actually strengthens aircraft windshields against impact at low atmospheric temperatures.

Tests conducted according to the standards of the Civil Aeronautics Association in which ducks, chickens, and other fowl were actually shot at the windshields at speeds equivalent to those of planes in flight show that for the most efficient protection, the plastic interlayer of laminated plate glass should range from 80 to 120 F.

Even when the treated glass is subjected to low temperature, the electrical current passing over the glass coating will maintain the plastic interlayer within this range thus increasing its resistance to collision with birds in flight.

Electrical contact to the transparent coating is made by applying metallic bus bars to the edges of the glass area. The newly developed treatment can be effected on plate glass, laminated safety glass, and multiple-glazed units designed for both civilian and military aircraft.

# *The* ARMY'S RESEARCH PROGRAM

## *Role of the Research and Development Division, War Department General Staff—Organization for the Future*

By MAJOR GENERAL H. S. AURAND, U.S.A.

DIRECTOR, RESEARCH AND DEVELOPMENT DIVISION, WAR DEPARTMENT GENERAL STAFF

YOU, who have come together to honor Doctor Lawrence,[1] represent many branches of engineering and science. Also, you have given me the privilege of making to you my first public statement as the first director of the recently created Research and Development Division of the War Department General Staff. It is a privilege because as engineers and scientists you represent a primary research and development asset of the nation both in peace and in war. It is a privilege also because the occasion is one for the formal recognition of a great contribution to research—the invention of the cyclotron, symbolic of the powerful tools of modern research and of the new importance justly attached to research and development of the future.

The continuance and improvement of laboratories for scientific research is of primary interest and concern to the War Department. Our program is, and must continue to be, one for preparedness; and it is your job and mine to see to it that we do not lag behind any possible enemy either in nuclear physics or in any other field of research and engineering of importance in the defense of the nation.

### ATOMIC ENERGY

We in the Army are fully appreciative of the importance of the discoveries and engineering application of nuclear physics. We are reorienting our concepts and our programs to take account of the changes wrought in the art and science of modern warfare by this new and potent military tool. At the moment, we are in the progress of planning to accommodate our research and development in the atomic-energy field to whatever agency the Congress may choose to create as the organizational structure for this purpose. Our interest is solely in doing our part as soon as possible. While uncertainty exists as to the future organization, we have no other choice than to continue with the present one.

### NATIONAL SCIENCE

While this same fact is true in other research and engineering fields, we are faced there with an even more difficult problem. The Office of Scientific Research and Development, with its subordinate agencies, is in the process of demobilization and is taking on no new problems. Its permanent alter-ego, the Natonal Science Foundation, has not yet been legislated into existence. It is necessary for the research and engineering of the armed forces to continue during this interim period. So the publicly owned laboratories and drafting rooms, as well as the research and engineering staffs, of our educational institutions, industries, and foundations, are being put to work in as orderly a manner as possible by the research and engineering agencies of the War and Navy Departments.

### THE JOINT RESEARCH AND DEVELOPMENT BOARD

These two top-level national agencies of co-ordination and implementation of research and development are still in the future, even though it may be the immediate future. To the Armed Forces, the contact with civilian scientists and engineers of the nation which these organizations would provide is not available. To assist in maintaining existing contacts and making new ones, as well as to assure co-ordination between the War and Navy Departments, the respective Secretaries have set up the Joint Research and Development Board. In its charter they not only gave it a "blank check" of authority but also, and more important, they obtained the services of the former head of the Office of Scientific Research and Development as its chairman—Dr. Vannevar Bush. This is a five-member board, including the chairman. The Navy members are Assistant Secretary Kenney and Admiral Ramsey; the Army members, Generals Spaatz, commanding the Air Forces, and Devers, commanding the Ground Forces. So far this board has had only its organizational meeting. But the strength given it by its charter, chairman, and membership can be expected not only to fill the gap between the Office of Scientific Research and Development and the creation of some sort of successor, but also to be of great assistance to the National Science Foundation or whatever the permanent national organization may be called.

The Joint Research and Development Board has set up a secretariat in Washington in the New War Department Building on Twenty-First Street. This full-time secretariat consists of four members, two of whom are to be civilian and one each from the Army and Navy. The executive secretary, who is one of the two civilians, is Dr. L. V. Berkner. Under his able guidance, the various operating committees of the board are taken over either from existing joint agencies or are newly created. It is with great pleasure that I announce at this time that the Army member of the secretariat will be Major General A. C. (Tony) McAuliffe. While McAuliffe is best known as the hero of Bastogne, he was assigned to research and development work in 1940 and 1941, and is now at Bikini.

One of the permanent committees of the Joint Research and Development Board is the Atomic Energy Committee. The Army membership of this committee, which is now under consideration, will also link the Army with whatever agency for the development and control of atomic energy Congress may create.

### WAR DEPARTMENT DIRECTORATE

I would not want to leave you with the impression that we intend to be progressive only in the field of nuclear physics, for this is surely not the case. Equally, our program provides for progress in research and engineering for guided missiles, radar, biological warfare, and other modern tools of warfare. That the War Department means business in this matter is amply demonstrated by the creation at the highest staff level of a directorate for research and development. To see where this organization fits in the research and development picture, recall

---

[1] At the conclusion of General Aurand's address, Dr. Ernest Orlando Lawrence, University of California, Berkeley, Calif., was presented the Holley Medal of The American Society of Mechanical Engineers, by D. Robert Yarnall, president A.S.M.E., "for originating the cyclotron."

Presented at the Annual Banquet, Los Angeles, Calif., July 26, 1946, of the Los Angeles Engineering Societies of Founder Societies.

that on the national, or presidential, level, there will be the Atomic Energy Commission and the National Science Foundation. In addition to many existing governmental organizations on the cabinet level, such as the National Advisory Committee for Aeronautics and Bureau of Standards, there is, and will continue to be, the Joint Research and Development Board created by the Secretaries of War and Navy. Within the War Department, at the Chief-of-Staff level, is the directorate for research and development. The director reports directly to the Chief of Staff and Secretary of War. Within the War Department it initiates, allocates, co-ordinates, supervises, and assures the progress of research and development projects. But perhaps more important than its internal duties are those in connection with contact with the civilian scientists and engineers of the nation.

In June, when he established this directorate, General Eisenhower announced the War Department research and development policy. Doctor Bush felt that the new policy augured so well for the future that he sent a copy of the announced policy to each of the scientists and engineers who had been associated with him during World War II, together with a request that each of them co-operate during peace in the new program as they had done so well during war in the old one.

Here are some excerpts from General Eisenhower's policy memorandum:

> The future security of the nation demands that all those civilian resources which by conversion or redirection constitute our main support in time of emergency be associated closely with the activities of the Army in time of peace.
>
> The lessons of the last war are clear. . . . . The armed forces could not have won the war alone. Scientists and businessmen contributed techniques and weapons which enabled us to outwit and overwhelm the enemy. . . . . This pattern of integration must be translated into a peacetime counterpart which will not merely familiarize the Army with the progress made in science and industry, but draw into our planning for national security all the civilian resources which can contribute to the defense of the country.

### FIVE POLICIES

General Eisenhower listed five policies to be put into effect to achieve these ends. I will endeavor to state these policies and show how they are being put into effect.

The first policy is: "The Army must have civilian assistance in military planning as well as for the production of weapons." At the moment, two actions are being taken to put this policy into effect. One is the creation of a War Department Civilian Panel of outstanding scientists and engineers. Both the natural and social sciences will be embraced in this panel. The other is the creation of a strategic committee of the Joint Research and Development Board. While the Board has not yet approved this committee, present plans include civilian chairmanship and panel, as well as the membership of the chiefs of planning and research of the Army and Navy, and the Army and Navy members of the Joint Research and Development Board secretariat.

The second policy is: "Scientists and industrialists must be given the greatest freedom to carry out their research." In so far as this applies to the attitude of Army personnel, the Research and Development Division will police the policy. More concretely, the policy will apply to the contractural relationship between the Army and the universities, industries, and foundations conducting research and engineering for it. Within the limits of present laws governing government contracts, all possible freedom will be given. But something more is necessary to implement this policy. That is a change in the contract law to permit the full freedom of the scientist and engineer envisaged by this policy. Both the Army and Navy have urged the Congress to make such change, and bills for the purpose have been introduced.

The third policy is: "The possibility of utilizing some of our industrial and technological resources as organic parts of our military structure in time of emergency should be carefully examined." At the moment the implementation of this policy is in the purely planning stage. The assistance of the War Department Civilian Panel is badly needed in connection with this policy.

The fourth policy is: "Within the Army we must separate responsibility for research and development from the functions of procurement and distribution." This policy has been put into effect by the establishment of the Research and Development Division on the same level as the Service, Supply, and Procurement Division of the General Staff. It will be completely in effect when legislation on research contracts is obtained, and supervision of these contracts can then be removed from the same supervision as that of the normal procurement contract.

The fifth policy is: "Officers of all arms and services must become fully aware of the advantages which the Army can derive from the close integration of civilian talent with military plans and developments." The implementation of this policy is an intra-Army affair. It can be brought about primarily by the indoctrination of Army personnel. Both this indoctrination and the policing of the policy are within the cognizance of the Research and Development Division.

### THE GENERAL POLICY

General Eisenhower's final paragraph stated:

> In the interest of cultivating to the utmost the integration of civilian and military resources and of securing the most effective unified direction of our research and development activities, this responsibility is being consolidated in a separate division on the highest War Department level. The Director of this Division will be directly supported by one or more civilians, thus insuring full confidence of both the military and the civilian in this undertaking. By the rotation of civilian specialists in this capacity we should have the benefit of broad guidance and should be able to furnish science and industry with a first-hand understanding of our problems and objectives. By developing the policies outlined above under the leadership of the Director of Research and Development, the Army will demonstrate the value it places upon science and technology and further the integration of civilian and military resources.

To carry on this policy, I am bringing into the Division on an annual rotational basis a group of top-flight engineers and scientists recruited from the laboratories of our educational institutions, foundations, and industries. They will assist me in the same manner as officers assigned to the Division. It is expected that one of these men will serve as my deputy, so that he will be in a position of authority adequate to discharge his responsibility for the maintenance of an effective relationship between the civilian and the military research and development effort. In addition, as I mentioned before, we are forming a War Department Research and Development Civilian Advisory Panel whose members, individually and in groups, will collaborate with us in the solution of special planning and technical problems which may arise from time to time. Only with the active and continuous help of men like yourselves, so highly trained and experienced, can we expect to keep abreast of the times in this new atomic age. This business of having to hang together or hang separately was never more applicable than it is today to the civilian scientist or engineer and the military.

### THE FUTURE

So far in these remarks I have endeavored to describe the organizations and policies for research and development from the War Department viewpoint. The Director of Research and Development has the primary War Department interest in the application of national scientific resources to the solution of military problems. As Director of Research and Development,

(*Continued on page* 833)

# INDUSTRIAL DEVELOPMENT *in the* SOUTHEAST

By JOHN P. FERRIS

DIRECTOR, COMMERCE DEPARTMENT, TVA, KNOXVILLE, TENN. MEMBER A.S.M.E.

MOST mechanical engineers have an intense interest in industry and in the role engineers play in stimulating industrial progress. Research that results in better products or more efficient processes is a stimulus to industrial development. Through their research activities, engineers have helped to make American industry what it is, and to make possible the present standard of living of the American people. How much better living conditions can be in the United States and in the world—and how soon—will be determined in large part by the kind of research done and by the effectiveness with which the results are applied.

Industry, of course, is built upon the results of many types of research—including that to discover more about the physical laws of nature, engineering applications of such basic knowledge, and related social and economic research.

A novel approach to industrial development has been tried out in the Southeast during the last 12 years. It is based upon the assumption that in order for modern technology in a given industrial field to achieve its ultimate in usefulness, it is necessary to mobilize all relevant research activities, and to bring them to bear upon the problems which individual businessmen face. To accomplish this objective, it is essential that the results of all forms of research are integrated and interpreted in such a manner that those concerned can apply them to specific situations. None of the activities in this approach is new in itself. What is new is that many public agencies are co-ordinating their research efforts and focusing them on the solution of specific industrial problems. Four kinds of activities on the part of the public research agencies are involved:

1 Assembling information about the kind, quality, quantity, and location of specific resources that are available for use by businessmen.

2 Conducting technical and industrial economic research necessary to determine the best alternative ways in which these resources can be used.

3 Identifying the individuals or groups of individuals who have the incentive, initiative, and capacity to apply modern technology in particular businesses related to opportunities revealed by research.

4 Working with these individuals or groups, to assist them in applying modern technology to the utilization of resources with profit, and at the same time to produce goods and services that can be of maximum benefit to the people as a whole.

The development of a new quick-freezing industry in this region since 1934 illustrates this approach concretely. The facts which follow may be useful in appraising the results.

### APPLICATION OF STUDIES IN QUICK-FREEZING INDUSTRY

1 In 1934 the fruit and vegetable farmers of the mid-South, and specifically those growing strawberries, were in trouble. Their principal markets were in the North and East, and most of the berries were sold on the fresh market. The prices to growers fluctuated violently, often from as low as $1 a crate to as high as $5 in a growing area, depending largely upon the volumes of fresh berries received at given times at the distribution points. This region's strawberry farmers could make money when the market was high, but often they lost even what they had spent for picking and crating. Many were getting out of the business.

Although strawberries were being processed by freezing in other production areas, there were no plants in the mid-South.

Here was a group of resources, soil, labor, and capital, not being fully utilized. The essential data about them were obtained.

2 There would have been little value in perfecting applicable methods of freezing strawberries unless markets were available; yet there might have been unlimited markets which could not have been satisfied unless processing techniques were refined and put to use.

Clarence Birdseye and others were found to have done important work on the "quick-freezing" of perishable foods and storing them at low temperatures. In the South, Dr. J. G. Woodroof of the Georgia Agricultural Experiment Station, was conducting significant researches. Engineers at the University of Tennessee were exploring possibilities for expanding the use of refrigeration for food preservation in the Southeast.

Both the University of Georgia and the University of Tennessee were anxious to continue their researches. TVA joined them in studying several quick-freezing processes and their applications under local conditions. All three organizations shared in the expense. Equipment was constructed and operated experimentally.

Dr. Woodroof's work concerning the effects of low temperatures upon food cells pointed toward the desirability of a process which would freeze very quickly, yet at only moderately low temperatures. The "immersion" process, developed through this joint effort, accomplished the desired result. At the same time it was applicable to operation in relatively small units suited to the scattered crop acreages typical of this region at the time.

The economic investigation of the markets for frozen fruits and vegetables was undertaken jointly by the University of Tennessee and TVA. Preliminary study indicated a large available market for frozen strawberries, the volume depending principally upon the quality and type of package. The demand was increasing rapidly, while at the same time the frozen-food industry was expanding in other parts of the country. In 1941 the final market study was published by the University of Tennessee as a book entitled, "The Frozen Food Industry," widely regarded as the best study in the field.

3 The farmers were still selling their strawberries on the fickle fresh market, generally with disastrous results. Businessmen in this region were still skeptical about quick-freezing and about the sources of supply of berries for quick-freezing.

Based upon an address presented at the Spring Meeting, Chattanooga, Tenn., April 1–3, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

WINTER GARDEN
FROZEN FOODS LOCKER STORAGE

ONE OF THE COMMERCIAL FREEZING PLANTS TO WHICH TVA FURNISHED TECHNICAL INFORMATION OBTAINED IN FOOD-PROCESSING RESEARCH

Demonstration was needed. Farmers needed to know what kind of strawberries could be frozen successfully; when to pick them; how to deliver them. Potential processors needed to know that they could depend upon the farmers to deliver enough berries to justify a plant; that they would be of the proper varieties and quality; and that they could sell the product. This demonstration, conducted in an experimental pilot plant, gave convincing answers to all these questions, and showed a satisfactory return to producers, processors, and distributors.

When businessmen and farmers saw how modern technology could be applied to their problem and the results that could be realized, many became interested. The new markets could be obtained only if some commercial quick-freezing plants were established. Because of lack of interest in the local situation on the part of established concerns, it was clear that if there were to be such an industry here, the people of the region would have to create it for themselves. As a result of their efforts, there are now six frozen-food plants in the Tennessee Valley, enough to handle all the suitable fruits and vegetables now being produced in the region.

Various processes are used. Production of strawberries and other fruits and vegetables is increasing. The present plants represent an investment of $400,000 and have a capacity of 10,000,000 lb of frozen foods annually, with a sales value of some $2,000,000 a year. They are located at Bells, Tenn., Cleveland, Tenn., Johnson City, Tenn., Knoxville, Tenn., Portland, Tenn., and Dayton, Tenn. The plant at Dayton is a farmers' co-operative, i.e., a private enterprise operated by the growers themselves.

4 Farmers and processors both had difficulty in coping with problems, differing in each locality and in each plant, which they were not equipped to solve themselves. Competent technicians on the staffs of the research agencies assisted. Without this help it seems likely that some of the new business undertakings would have failed. Most of them are on a firm basis now, but still need research help in order to keep abreast of any new developments.

A recent analysis indicates the need and opportunity for continuing to work with businessmen and farmers. If and when the farmers produce enough fruits and vegetables in concentrated areas within which they can be economically delivered to freezing plants, it appears that from 7 to 10 additional plants might be successfully established, more than doubling the investment in this industry. Two such new plants are being started. But it will take time to solve all the problems involved.

### RESULTING BY-PRODUCT ACTIVITIES

Following the activities described, by-product results to which they contributed appeared. The freezer-locker industry began to enter the Southeast; 124 plants are now operating in this general area, and many more will certainly be built. Cold-storage and freezer space has been erected and more such establishments are contemplated.

Managers of these plants do not "cuss out" the public research agencies, but instead many say that the success of their business efforts has rested heavily upon the technical and economic assistance they received, not only from universities and TVA, but also from some other public agencies. The U. S. Department of Agriculture has played an important part, especially in establishing standards of quality of products, inspection, etc.

As a result of the knowledge concerning various quick-freezing processes and the business problems of the industry acquired by various participating agencies, interested individuals frequently request information and suggestions on organizing and operating freezing plants. Now, after some 12 years of growth of this new relationship between businessmen and public agencies, such inquirers know where to go for information, i.e., to the agricultural extension services about crop possibilities; to agricultural experiment stations, engineering colleges, or TVA, for technical and economic data; and to private consulting firms on their special problems.

Instead of confusion from a multiplicity of agencies trying to be useful to the citizens they serve, these efforts have been integrated effectively. The public agencies involved have worked together, the TVA maintaining close contact with the entire situation and filling certain gaps which have occurred. One reason this can be done is that TVA's principal offices are in the Valley. Its responsible technicians live in the region, so that the many benefits of frequent direct contacts can be realized.

Private consultants, particularly in engineering and architecture, have already played a significant role in the expansion of the southeastern quick-freezing industry. The kind of public

IN THIS UNIT TVA CONDUCTS EXPERIMENTS RELATING TO CROP PREPARATION AND FOOD-PROCESSING

research activities which have been described result in increasing recognition of the need for consulting services.

It is thoroughly understood by all concerned that none of the public agencies attempts to supply the business initiative and drive; that the people must of course do that themselves; and that the capital must come from the customary sources.

### APPLICATIONS OF RESEARCH ACTIVITIES COVER WIDE RANGE

Quick-freezing technology is but one example of public research applied to business use in the Tennessee Valley. Private companies have incorporated some TVA developments in the electric-furnace reduction of ores. A kaolin producer uses an adaptation of a TVA method of refining. Co-operative research by universities and TVA in agricultural engineering has resulted in expanded industrial activity, including manufacture of light trailer threshers, castor-bean hullers, and equipment for the first practical method of artificial hay drying on small farms. Three companies are manufacturing a publicly developed cottonseed pressure cooker, which some eighteen oil-extraction mills are using. Many other research results are being applied industrially.

Other agencies are conducting important research activities. At New Orleans, for example, the U. S. Department of Agriculture operates one of its four large regional laboratories, conducting many research projects on the industrial utilization of southeastern farm crops.

Some of the larger industries operating in the Southeast have expanded their research activities greatly, their findings being primarily of course for their own use.

The Southern Research Institute, a private nonprofit organization, affords large and small businesses technical research services on a fee basis, using revenue for operations, expansion of facilities, etc. Still other public and private research organizations are offering similar services, and thus are helping lessen the Southeast's research deficiency, which is still, however, very great.

### ECONOMIC BACKGROUND OF SOUTHEAST REGION

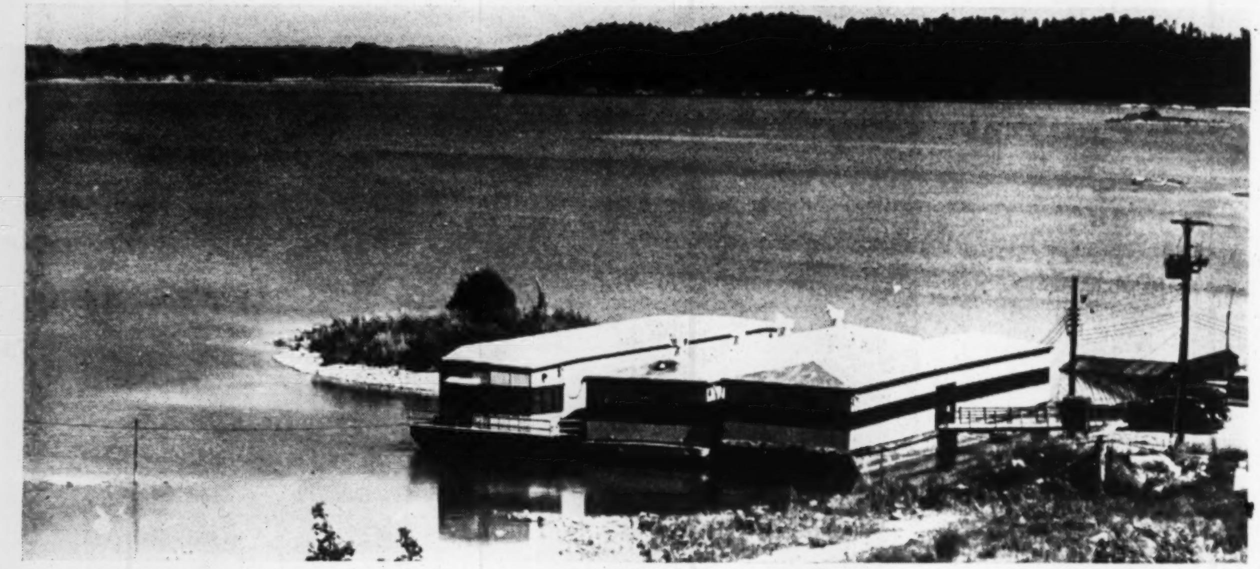
In evaluating the work which has been described here briefly, it seems important to have in mind some of the key facts about the economic background of the Southeast in relation to the national economy. It should be borne in mind, for instance, that the Southeast has for generations been devoted primarily to agriculture, to the extraction of raw materials, and to the production of low-grade industrial products, such as pig iron, lumber, etc. This has exhausted resources far too rapidly, often with little benefit to the great mass of the people of the region. Yet the remaining resources are sufficient to support a substantial expansion of industrial and other economic activity, especially if modern technology, the abilities of the people, and the facilities of their institutions are applied in a joint effort to develop resources in accordance with conservation principles.

There is an increasing awareness of the fact that if satisfactory income and living standards in the Southeast are to be achieved there must be a further increase here in the industrial processing of the region's raw materials. In 1939 the southeastern states produced only 54 per cent of the national average per capita value of manufactured products, and the people lived on 56 per cent of the national average per capita income. Income in the Southeast will continue low as long as the economy remains geared so largely to raw-materials production. With income low, just so long will social services, such as education, suffer. Most southern leaders have long been aware of this vicious circle, and are resolved to strengthen the region's economic foundations.

Hundreds of southeastern communities are striving for something more fundamental which underlies the permanent improvement of income. In such communities, business leaders know that industry cannot make its best contribution to the prosperity of the people unless the underlying agricultural development is sound. This conclusion seems inescapable in view of the climate, topography, and soils of the region. Furthermore, industries of the region now use agricultural products for some two thirds of their raw materials.

As in many other parts of the world, there is a quest under way here for the basic things which nature demands that agriculture and industry do together primarily as partners in utilizing the natural resources provided for man.

The growing of plants on the soil and their nourishment of animal and human life constitute the first steps in the use of basic resources, and of the energy from its source, the sun. Another step, responsibility for which is carried by much of our industry, lies in receiving the crops, or animal products, or forest products from the rural people and applying industrial skills and industrial facilities to their processing for human use.



TVA'S FOOD LABORATORY IS HOUSED IN THE SUPERSTRUCTURES OF THREE RIVER BARGES
(When the program in a particular area is concluded the plant may be towed intact for research elsewhere.)

Still another step, responsibility for which is assumed by much of our nonmanufacturing business, is in the commercial distribution of the resulting products through the channels of trade until, at the times and places they are needed, they fulfill the requirements of people for good living.

In some places these interrelationships are well understood and have very practical consequences. Business leaders in one southeastern town were about to set up an alfalfa-hay dehydration plant, the gross income from which would probably have been about $200,000 a year from shipping dried alfalfa to distant markets. Farm leaders showed that the soils of the county could not well stand the continuing loss of fertility involved, and that a better over-all project was to expand dairying, consuming the hay locally on the farms, and returning some 80 per cent of the fertilizer elements to the land which produced them. The hay is locally dried by means of simple power-fan installations in farm barns. The city businessmen lent their support to this alternative. The gross income to the county under the latter program should before long reach about $250,000 a year. The fact that it will in the first instance go to the farmers instead of to them occasions no concern to the city business leaders, because they realize that their town's business income reflects the purchasing power of the farmers of the trade area.

### INDUSTRIAL ENVIRONMENT IMPROVED

The environment in the mid-South for expanding business and the development of new industries have improved during the past decade, partly due to the new facilities which TVA has made available. Some 2,000,000 kw of reasonably priced electricity, widely distributed, have been added to the energy supply of the region. A 9-ft navigable channel connects the mid-South with the Middle West, providing low-cost transportation (largely of bulky raw materials and fuels) to supplement rail and truck facilities. The series of dams has the flood menace to industry in the cities along the Tennessee River pretty much under control, and has aided in controlling floods on the Ohio and lower Mississippi. Conservation and agricultural-development activities are strengthening the soil of the Valley and of the nation, and people directly dependent on the land are able to make a better living; they have more money to spend.

The industry of the Southeast is slowly but definitely changing. Beginning about 70 years ago, an industrial growth began which, in addition to its direct results, spread "industrial mindedness" and gradually built up a body of skilled labor. It was found during the recent war that manufacturing operations making high demands on skill, were satisfactorily carried on in the industries of the Southeast. A manager of a dive-bomber plant, for instance, said that requirements for skill were no harder to meet than anywhere else, and that over-all efficiency of workers was fully as high here as anywhere.

Recently the rate of manufacturing growth in the Southeast has been substantially greater than in the nation as a whole. Between 1933 and 1939 the value of manufactured products increased 68 per cent in the 122 counties of the Tennessee Valley watershed. In the United States as a whole the increase during the same years was 53.7 per cent. Income from factory pay rolls increased 56.8 per cent in the same 122 counties, as against 46.5 per cent for the nation. During the same period and for the same area the figures for increases in the number of manufacturing establishments were 53.5 per cent, and 30 per cent respectively.

More specifically, there were 405 new manufacturing establishments set up between 1933 and 1943, in an area encompassing the power-service area of the TVA, as well as the drainage basin of the Tennessee river. The diversity was very great, running from sport socks to ferro-manganese; from dried eggs to dive bombers; from pencils to concrete blocks.

### ENTIRE NATION BENEFITED

As this evolution in the utilization of the resources of the Southeast advances, benefits flow to the entire nation. One manifestation, and an important one, is the immediate increase in southeastern purchases of goods from other regions. If family expenditures in the Tennessee Valley should reach national averages, the increased consumption of such goods as clothing, housing, refrigerators, furniture, and automobiles would create a new market, the magnitude of which is probably of the order of some $4,000,000,000 per year.

Faith in abundant production has nothing to do with sectionalism. It implies rather that all regions of the nation should develop agriculture, industry, and other business activities in so far as possible up to the limits set by sound resource utilization principles, by business enterprise and leadership, and by access to the necessary scientific and technical information.

The people of this country (and for that matter, the people of the world) really want as much goods and services as present and potential industrial plants can make; and they are willing to work for them. Surely everyone would prefer raising the level of national production and income, through the best development of the resources of every region, to any "return to normal," whatever "normal" means. If the United States should return to the level of production and income of just before the war, schemes to "divide up the work," "divide up the market," and "divide up the income" would no doubt prevail. But the ability of this nation to produce, demonstrated during the war as being far above prewar levels, means that if high production is not maintained neither can employment nor income be maintained at high levels. Increased income can come only out of such increased production. Out of the increased income the people buy the products of other regions, and they pay for more social services, better education, health, etc.

This is precisely the process concerning which there has been much discussion in the international field. A great deal of American enthusiasm has been expressed for American aid in the economic development of other nations, including the encouragement of industrialization to make their populations more productive, it being pointed out that this will result in great new markets for American goods. This perfectly sound doctrine has been advocated for China, for Brazil; in fact, for many of the relatively undeveloped areas of the world.

If the principle is desirable in the international arena, it would seem to be desirable as applied to the underdeveloped regions in the United States. Something consistent with it is actually happening in the Tennessee Valley.

### ESTABLISHING RELATIONS BETWEEN BUSINESS AND RESEARCH

The activities leading to the expansion of the quick-freezing industry, and the others to which brief reference has been made, involved making certain assumptions concerning effective relationships between businessmen, farmers, and others interested in new business on the one hand, and the public and private agencies concerned on the other.

One assumption is that industry and business are responsible for making the decisions on how resources are to be converted into goods and services through the application of technology. This is not a new assumption; it is one of the fundamental ideas upon which our economic system is based. Individual enterprise, of course, assumes many forms, including corporations, co-operatives, partnerships, etc.

A second assumption is that industrialists and other businessmen need a great deal of technical and economic information in order to make these decisions, i.e., in order to decide whether to expand an existing business or to undertake a new one. This is especially true for small enterprises. Because of the typical interest of public agencies in the widening of economic opportunity, many of them make unusual efforts to assist smaller businesses, which tend to create opportunities for large numbers of individuals.

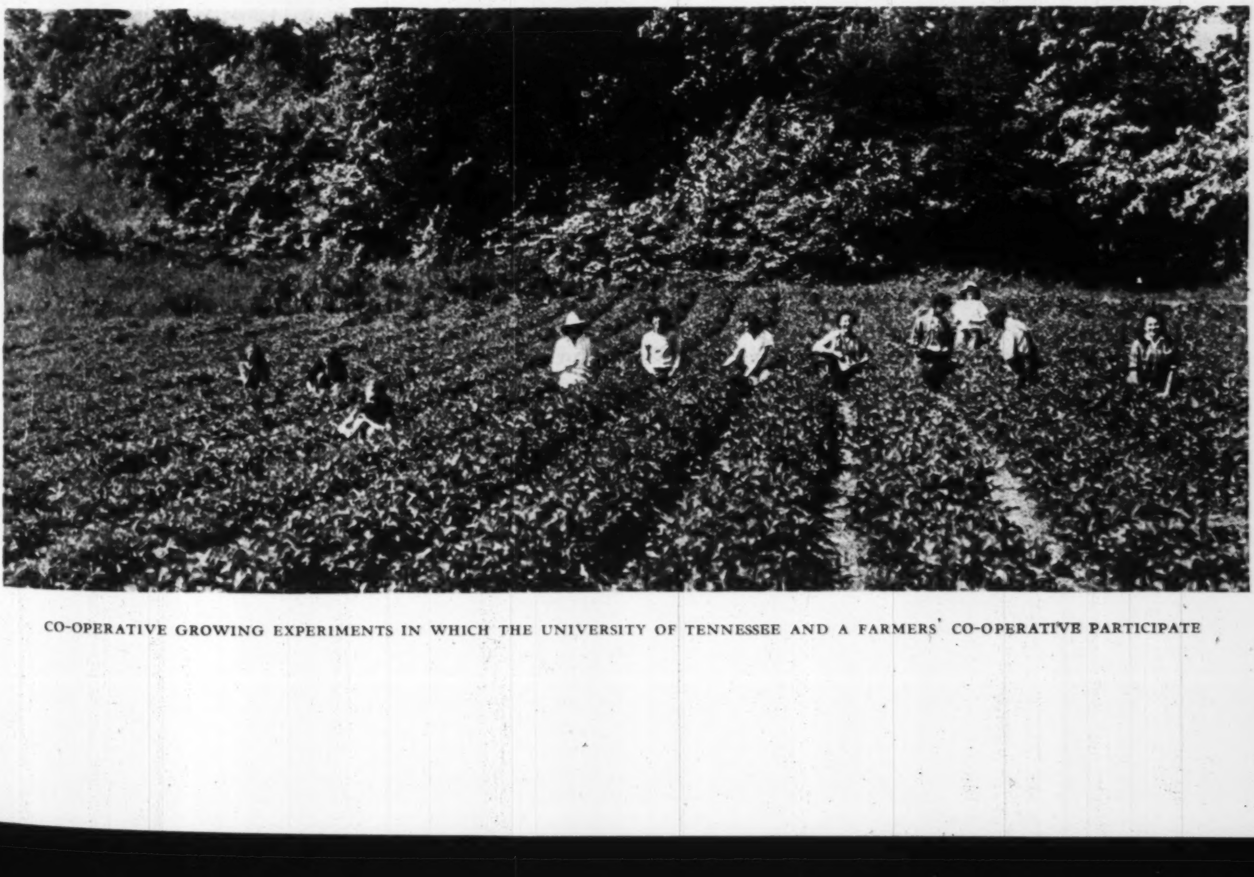
A third assumption is that public agencies can and should contribute heavily toward making needed technical and economic information available to business people.

A fourth assumption is that a new relationship is needed in America between public and private groups concerned with technological development, which recognizes the responsibilities of each.

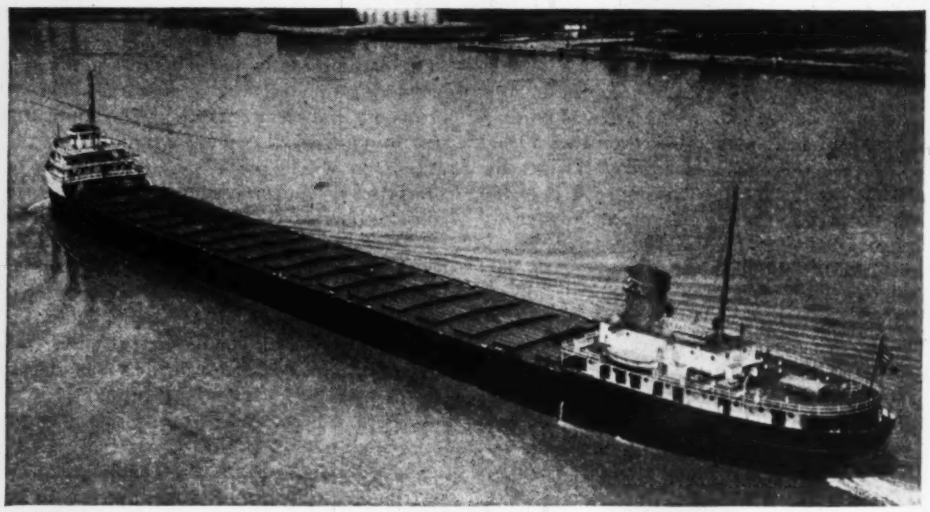
### CONCLUSION

In the Mid-South there are the beginnings of a new relationship between business and public agencies. Here in the Tennessee Valley there is a new interplay of ideas between many business people and many public agencies engaged in research or other activities bearing upon business; mutual confidence and respect are definitely growing. Many visitors from other parts of the world say that they know of nothing like it anywhere.

While the region has made great economic progress in recent years, there is still much to be accomplished. The per capita income of the Southeast as a whole was still only 58 per cent of the national average in 1941. But it is highly encouraging that things are moving in the right direction.



CO-OPERATIVE GROWING EXPERIMENTS IN WHICH THE UNIVERSITY OF TENNESSEE AND A FARMERS' CO-OPERATIVE PARTICIPATE



M.S. "HENRY FORD II"

# DIESEL POWER *of* M.S. "HENRY FORD II"

By MALCOLM McLAREN

CHIEF ENGINEER, MOTORSHIP HENRY FORD II

THE motorship *Henry Ford II* is of the lake type with engine room aft, having a length of 612 feet, a beam of 62 feet, a draft of 24 feet, gross tonnage 8877 tons, and net tonnage 7074 tons. The crew consists of 34 men, of whom 11 are assigned to the engine room.

In a normal season of about 8 months, extending from April 1 to December 1, the vessel carries approximately a million tons of cargo to the Ford Rouge plant.

The cargoes consist of iron ore, limestone, and coal, the ore being loaded at Lake Superior ports. It requires about 4 hr to load and about 9 hr to unload at the plant. The limestone is loaded at Calcite, Mich., and the coal at Toledo, Ohio. It is not unusual for the vessel to carry a 15,000-ton cargo to the plant. The amount of the load depends somewhat upon the depth of the Rouge River which varies as much as 18 in. during the season. On the run from the Rouge plant to where the cargo is taken aboard the vessel takes on water ballast which amounts to about 4000 tons. This ballast is pumped out as the cargo is received. The average speed of the vessel is 13 mph with cargo and $14^1/_2$ mph with water ballast.

The foregoing details will give some conception of what is required of the power plant. The engine-room crew is employed the year around as the 4 months' lay-up is required to overhaul the machinery which is always kept in first-class condition. The crew's quarters and the food are on a par with the best hotels.

### THE POWER PLANT

The power plant consists of a main engine of the Sun Doxford opposed-piston two-cycle type with a maximum horsepower of 3500 at 85 rpm; two 6-cylinder two-cycle Worthington engines of 450 hp at 274 rpm, each driving a 300-kw 240-v generator. They supply the current for the auxiliaries which are all motor-driven. One of these generators is always in reserve.

In addition there is a Junkers opposed-piston-type engine of 50 hp at 500 rpm, driving a 35-kw 240-v generator, which is used in an emergency for the steering gear only.

One donkey boiler, 15 ft 8 in. high and 6 ft diam, supplying steam at 150 psi, is used for steam whistle and heating water for the rooms and galley, as well as to keep the main-engine jacket water at the correct temperature when the engine is not in use.

The average fuel consumption for the entire power plant is approximately 175 gph; main engine 140 gph; Worthington engine 25 gph; boiler 7 gph; and Junkers engine 3 gph. The Junkers is only in operation in close quarters, such as making and leaving port, and running the rivers.

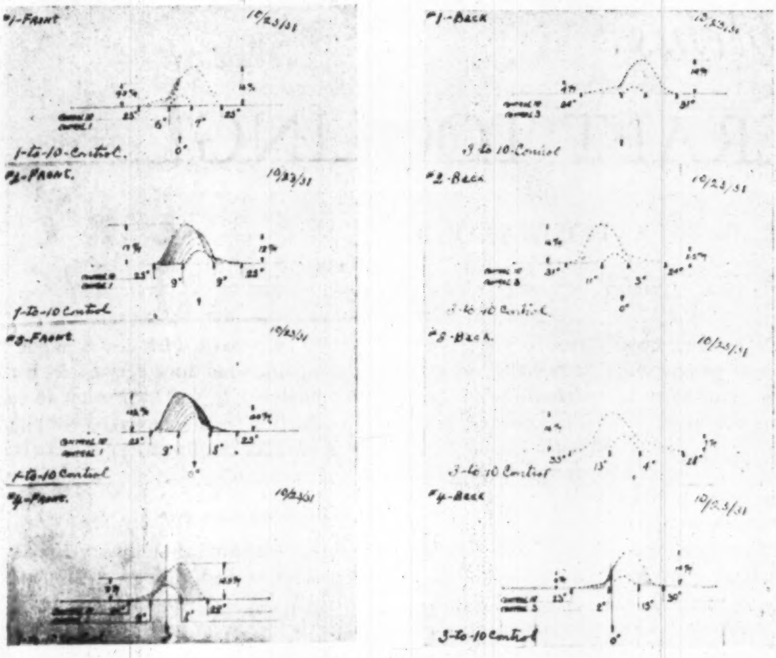
### MAIN ENGINE

As noted, the main engine is a Sun Doxford, opposed-piston, two-stroke-cycle type with solid injection; cylinders are $23^5/_8$-in. bore, while the stroke of each piston is $45^5/_8$ in., giving a combined stroke of $91^1/_4$ in. The mechanical efficiency is approximately 90 per cent thus providing a shaft horsepower of 3150.

Referring to the cylinder construction, the liners are 11 ft in

---

Contributed by the Oil and Gas Power Division and presented at the Semi-Annual Meeting, Detroit, Mich., June 17–20, 1946, of The American Society of Mechanical Engineers.



(Front valve-lift cards) (Back valve-lift cards)

FIG. 1 COMPLETE INDICATOR CARD TAKEN ON MAIN ENGINE

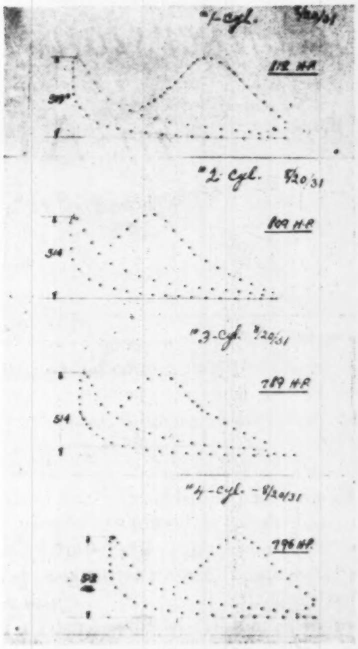


FIG. 2 INDICATOR, AND COMPRESSION CARDS TAKEN ON MAIN ENGINE

length and the exhaust ports at the top are opened to a considerable extent by the passage of the upper piston, before the scavenging ports at the lower end of the cylinders commence to be uncovered by the bottom piston. The scavenging air is furnished by an independent motor-driven blower of 10,000 cfm capacity at 2 psi pressure.

There are two fuel valves for each cylinder, the one in the front of the engine being slightly above the mid-point of the liner, while that at the back is somewhat below. The rear valves are not in operation while the engine is running astern. The fuel valves are operated by a camshaft which receives its motion through a system of gears from the main shaft. The lubrication of the engine is on the forced-pressure system.

In maneuvering, the engine is started with air pressure of 600 psi, and after one revolution the fuel oil is cut in at 2000 psi pressure. There are two main fuel pumps; an independent motor-driven pump which is used to supply fuel pressure when maneuvering, and a fuel pump which is driven from the main-engine shaft, for use when the engine is in operation. The engine can be slowed down to as low as 18 rpm and up to 85 rpm on the fuel oil used.

The cylinders are water-jacketed and the water temperature must be kept at 150 F for starting purposes. The water jacket is also used to maintain the cylinders at the proper temperature while the engine is in operation.

It might be well to state that the engine is heated up at the start of the season and not allowed to cool off until the end of the season. This stops expansion and contraction and prevents water leakage from the jackets.

For economical and smooth operation it is important to keep the engine equalized, that is for each cylinder to deliver the same amount of horsepower, this is, very easily done on this type of engine and adjustments can be made while the engine is in operation.

There are three types of indicator cards that can be taken from the engine to assist in balancing it. They are "power" cards, "valve-lift" cards, and "compression" cards. The adjustments are made by increasing or decreasing the lift of the fuel valve.

A complete set of cards taken from the engine appears as Fig. 1.

It would be well for anyone interested in Diesel power to look them over. They were taken under actual working conditions, giving the valve timing, fuel consumption, ignition pressure, etc.

For successful operation and a minimum amount of liner wear, it is essential to use a good grade of Diesel fuel oil, which will greatly assist in keeping the engine repair bills low. Following is the specification of the fuel used on the vessel. The fuel is a hydrocarbon oil, free from grit and fibrous or other foreign matter likely to clog or injure the valves, and conforms to the following constants:

| Flash point F (Cleveland open cup), DF | Viscosity (Saybolt SU at 100 F) sec (max) | Water and sediment (AST D-96-28) per cent (max) | Carbon residue, per cent (max) | Sulphur, per cent (max) | Pour, DF | Ash, per cent (max) |
|---|---|---|---|---|---|---|
| 175 | 220 | 0.5 | 1.0 | 0.75 | 0.10 | 0.8 |

After a season's run, with the oil as specified, when the engine is opened up, no traces of tarry deposits are found in the cylinders, and all piston rings are perfectly free in their grooves. The piston heads are also found to be quite free from carbon or other deposits.

### AUXILIARY ENGINES

Each of the two auxiliary generator engines is operated alternately every 30 days. They supply the current for all the auxiliaries on the vessel, which are 70 in number, including 6 mooring winches, an anchor windless, 2 steering gears, 2 refrigerating machines, 2 hatch winches, and all service pumps. All service pumps are in duplicate and are used alternately.

(*Continued on page 796*)

# *Reconversion Problems* *in* AIRCRAFT TOOLING

By N. A. LOMBARD

DOUGLAS AIRCRAFT COMPANY, INC., SANTA MONICA, CALIF.

THE problems of reconversion in aircraft tooling have been, and continue to be, multitudinous and perplexing, but we hope they will not prove as difficult to solve as those problems we met and conquered during the war years.

### ECONOMIC PRODUCTION METHODS NECESSARY

All aircraft companies in their tooling reconversion policies have one thing in common, namely, their attempt to retain quality economically. The elimination of 1000-plane military contracts and the return to fixed-price commercial contracts necessitates the abandonment of mass-production methods in favor of economically engineered streamlined methods. This does not mean that we are returning to prewar methods. Indeed not! Our great war experience would be for naught if we did not take advantage of the lessons learned and the experiences gained. Our new policy will be one of compromise, as the required production, while nowhere near as great as during the war, will apparently be more than prewar.

The change from war to peacetime production creates an entirely different set of problems in aircraft from those in almost any other industry. It will be found that many industries have been faced primarily with the job of clearing the plants of war products and disposing of surplus or special war-required machinery. At the same time, they must put the balance of their machinery in first-class shape and reassign personnel to prewar positions, after which comes a short wait for final engineering prints, which in most cases are only slight revisions of 1940 or 1941 production models. Then materials are acquired and the plant is ready to start production about where it left off before the war, with only a short pause for the personnel to get back into the swing of a job which had been done for years in much the same manner. Typical examples of such industries are those manufacturing roller skates, tricycles, bicycles, electric motors, transformers, and other electrical equipment. The automotive industry should also be included inasmuch as many companies definitely had models ready for production.

Reconversion in the aircraft industry, however, is quite different. We do not have a prewar model that can be put into immediate production with only minor changes. We must change from high-production military models, based upon war requirements, to relatively low-production competitive models based upon safety, comfort, speed, and economical operation. The change is radical in that many high-cost methods and techniques that were so successfully used during the war cannot now be utilized because of their prohibitive cost. Likewise, we cannot revert to our prewar methods and techniques as they are not suitable for the new aircraft-production requirements. Our methods and techniques must be of a decidedly new order keyed to the new requisites.

During the war, time was the first consideration and cost was secondary. Today, however, the cost element is first and time is not second, but on an even basis with cost. When the war ended, most aircraft companies had done very little, if any, definite work on postwar models. It was necessary in most cases to start peacetime production with converted warplanes, while planes 2 or 3 years in advance of present types were being designed for production.

### AIRCRAFT DESIGNS CHANGE RAPIDLY

It must be remembered that the aircraft industry is truly a young one, and therefore progress and change in design are extremely rapid. Generally speaking, when a new design is initiated, it is out of date before it is really in production. Occasionally, companies have found that a group of their own preliminary designers have out-dated a model about to be put into production. This rapid revision of designs is occasioned not only by newly discovered aerodynamic principles, but by new advancements brought out by associated manufacturers in such things as motive power, propellers, etc., as well as those in the basic materials. In dural alone there have been two major improvements in the last 5 years, namely, the 14- and 75-type materials. Both of these materials required very extensive tooling programs to develop adequate cutting and forming techniques. Now we are faced with tooling-development programs on such things as stainless steel, magnesium, and still harder and lighter aluminum alloys.

Donald W. Douglas, in a recent report, very clearly stated the over-all problem when he said: "The industry is also faced with the fact that the complexity of new experimental aircraft has grown from year to year, while the probability of obtaining worth-while orders for a new model upon its development has decreased. Thus the cost of bringing out a new model has risen from a matter of a few hundred thousand dollars during the 1930's to a major undertaking of many millions of dollars in recent years, and there are no signs of a reversal of trend.

"Technological advances in both aircraft design and motive power are so rapid that development of a successful model is no longer necessarily followed by sizable orders, either commercial or military. To an increasing extent and as a result of these advances, a new model may become obsolete before quantity production is attained."

### PRODUCTION RATE

Another factor that enters into our postwar problems is that relating to rate of production. During the war, it was a case of speed to produce a quantity of airplanes; today, it is a case of speed to produce the first airplanes of a new model. As Mr. Douglas stated, in the past it cost a few hundred thousand dollars to produce the first model; today, the cost is many millions of dollars. A large portion of this increased cost is attributable directly to tooling because of the expense of producing not only production technique for new materials and designs, but also for development of heretofore unused and untried methods.

An important reconversion problem in aircraft tooling is that of reduction, reassignment, and realignment of personnel.

---

Contributed by the Production Engineering Division and presented at a meeting of the Aviation Division, Los Angeles, Calif., June 3–5, 1946, of The American Society of Mechanical Engineers.

The reduction in some companies will amount to as much as 75 per cent and calls for a very careful analysis of employees' qualifications and performance records to insure the retention of the best qualified for the work planned. This, of course, is of prime importance in the case of administrative or supervisory personnel. Those retained will be the very backbone of the tooling organization and to them will fall the responsibility of success or failure of the tooling reconversion program.

During the war many men in aircraft tooling were advanced rapidly to meet the demands of expanding production needs and additional plants. Very early the supply of tried and proved, as well as experienced men, was exhausted, and it was necessary to advance many about whom very little was known. They just had to be tried out, so, naturally, errors of judgment were made. Some men proved that they did not have what it takes to administer or supervise under pressure. A few of these men, however, are capable, efficient, and valued technical workers, and can and should be used as such; but others, for apparent personal reasons, will not be able to stand up under the downgrading process. They must be dropped. Still others, must be reduced a step or two because only a few of the qualified will be required to fill the reduced needs.

### THE DAY OF SPECIALISTS IS OVER

To meet the expanding requirements of the war, it was found necessary to develop and assign specialists to various detailed phases of tooling, such as punch-press dies, draw dies, stretch dies, drop-hammer dies, development, project work, etc. There was sufficient need for full-time men on each phase, but now requirements are such that one, or at the most, two men can handle a project which formerly required ten or twelve men. Careful thought and consideration must now be given to the selection of those best qualified by experience to carry on this work. In the analysis of administrative and supervisory personnel, three factors stand out, i.e., administrative ability, technical ability or job knowledge, and seniority. A point-by-point comparison of these factors and the personnel being considered will quickly identify the outstanding men. In the case of hourly workers, the task of reduction is somewhat easier, because generally speaking, seniority alone prevails.

Another phase of the personnel problem is the returning veteran. He must be placed in the best possible opening with due consideration for his present qualifications. This is a problem for specialized employment counselors.

If the personnel problem is adjudged correctly, the final results will show a smaller, but far more capable and efficient organization. This is the first requisite of a successful postwar tooling program.

### REARRANGING PLANT AND MACHINERY

The next problem to be solved is that of plant and machinery rearrangement. This is particularly true of plants that have had the greater portion of their equipment leased from D.P.C. and similar holding units. In this case decisions must be reached as to what type and quantity of machinery is to be retained. Such factors as size and type of airplane to be produced, amount of personnel to be retained, number of shifts and days per week the plant is to be operated, space availability, possible elimination of subcontract work, obsolescence of owned equipment, and capital investment permissible must be considered. Plant management will, of course, establish the basic policy of these factors, but tooling management must make the most efficient use possible of the space and budget allowed. Generally speaking, it will be wisest first to recondition or replace worn-out and obsolete company-owned machinery, then acquire such additional government-owned equipment as needs dictate. Here in Southern California where we have an abundant source of job shops it seems prudent to minimize on the quantity of ordinary machinery retained, and to provide the oversize and unusual machines for the plant. In any case prime consideration should be given to the elimination of obsolete and warworn machinery, for our machinery has had the equivalent of 10 years' service in the last 4 years.

### TOOLING RECONVERSION

Now we come to technical tooling reconversion which mainly concerns the problems of designing and fabricating tools to meet the new requirements. The present-day principle is that we must produce tools for more complicated parts, to a predetermined limited cost budget, in a shorter time and still retain wartime accuracy and quality. This may seem to be an insurmountable task, but it challenges the ingenuity, skill, and resourcefulness of the tooling engineers and designers in the same way, but to a different set of rules from those governing the activities of the last few years.

When we speak of more complicated parts, we refer to the natural evolution of aircraft design which must more and more meet the requirements of safety and speed in the design, and production economy in the manufacturing of the airplane. The design trend today is toward a so-called one-piece part, i.e., one that is machined from a single piece of raw material rather than an assembled part of riveted or welded sheet metal. This, of course, means less assembly labor, and fewer parts to handle, which results in over-all cost reductions. This problem, like others, will be worked out in various ways by different aircraft companies. Generally, however, it will be done through such means as specialized machines, single-purpose machines, and other types of precision machinery, which fact forecasts the need of capable machine-tool designers. This leads to the thought that no longer is man's productivity measured by the hours and minutes he works, but rather by the capacity and the efficiency of the machinery furnished.

To meet the requirements of economy in the new era of aircraft tooling, greater emphasis must be placed on predesigning, cost estimates, budget formulating, and compliance. Most of our work heretofore has been activated by the premise of "the most satisfactory design that could be built in the shortest time without too much thought to cost." Now we must work toward the principle of predetermining the cost of the most satisfactory tool that can be built in the shortest time, and at the same time see that that cost is not exceeded. This means that we must emphasize the activities of tool engineers who are thoroughly cost-conscious, and who can formulate budgets and preliminary designs after determining basic manufacturing methods.

### TOOL-DESIGN PROBLEMS

Going briefly into detailed tool-design problems, we find such things as the question of the retention of simple foolproof features without their usual high cost, the use of more and more so-called standard or universal tools, the use of Class B dies in place of Class A dies, and the development and use of machines capable of utilizing tungsten-carbide tools efficiently.

All of these design problems resolve themselves into the basic design problem of organization, for, after all, organization is a synonym for good design. Most aircraft companies are fortunate in that they have come out of the war period with an ample supply of quality tool designers. All that needs to be done is to indoctrinate the designer to cost-conscious thinking for reduced quantities of tool parts, and to impress upon him the importance of using as much "in stock" standardized tooling as possible. Our problem in this instance is strictly one of selecting capable supervision.

Assembly-line tooling methods are also due for some change. Wartime methods of multiplicity of assembly fixtures must be revised to one of single units, predicated on speed in assembly to conserve floor space as well as to permit a reduction in the amount of tooling. The assembly-tooling problem, however, is probably the least of our reconversion worries.

### TOOL PLANNING AND PROCESSING

The tool-planning or process-planning problem, however, is not so easy to solve, because here a thorough and complete reconversion must be made. Planners must be retrained in their basic thinking. First, they must relearn the first principle of planning, that "the cheapest tool is no tool at all." They must realign their analyses and thinking to the new relatively small quantity of parts required per week. They must consider the fact that in some cases and under certain circumstances, it is less expensive in the long run to produce parts by the machine-layout method than it is to provide a tool. The retention of certain types of production machinery, formerly kept in constant use but now used only occasionally, provides an additional opportunity for utilization in other ways. Likewise, certain machine tools formerly used full time for tooling will now be open at least part time for production. In this latter category are such machine tools as jig borers, horizontal-bar boring mills, and duplicating machines (including the Kellers). It can readily be seen that these points converge to the thought that the new-era tool planners must be more familiar than ever with type, quantity, and most of all, the loadings of the various machines and equipment that are at their disposal.

As previously mentioned, the idea of formulating budgets and preparing predesigns and basic manufacturing methods will be the task of a select group of planners guided and advised by project tool engineers. This phase is, without a doubt, the key to the entire aircraft-tooling-reconversion problem, for the primary plans will here be born, matured by the designers, tried by production, and accepted or rejected by the management.

A very important phase of our problem is that of prototype tooling. Many airplanes during the war were put immediately into production without the benefit of a prototype, or forerunner ship. This was only possible and expedient because it was felt that the airplane was of sufficiently proved design to warrant the risk of retooling such portions as required. Today, however, with the advent of radical and frequent changes in designs, the risk is too great, and we must revert to preliminary prototype tooling, but definitely not to the same technique. Prototype tooling now must be a carefully analyzed program based on a combination of prototype and production tooling. Wherever possible or feasible, permanent tooling must be provided in the beginning, while special prototype tooling as is furnished should be of such a type that it can be reworked, or added to, without destruction of the original. A program of this type is necessary in order that the time element between the prototype and the first production model will be reduced as much as possible. In the past few years, various types of specialists and project men have been trained to plan along these lines, and they now must be utilized to the fullest extent.

Another school of thought on this problem will advocate the establishment of an experimental tooling group to tool a prototype strictly on a one-time basis. This theory would call for a minimum amount of low-cost tooling that would in the main be scrapped with the advent of the production model. This plan would call for the design of the production tooling to be started during the prototype life, and tool fabrication to be completed immediately upon the acceptance by engineering of each prototype part or section. This plan would require the fullest co-operation between the engineering and tooling divisions. The selection of the most advantageous method will be determined on the basis of the type and complexity of the airplane design involved.

### CONCLUSION

The problems just mentioned are by no means all of the reconversion problems in aircraft tooling, but serve to illustrate the types of problems for which solutions must be found with the co-operation of the aircraft engineers, production men, and tool engineers. We must all stop being part of the problem and start being part of the solution. The solution of every problem has three phases, namely, assignment, execution, and ascertainment. In this case the assignment is to reconvert aircraft tooling from a stage of war-born expansion in which much progress and excellent results were attained in tooling noncompetitive military models, to tooling a peacetime highly competitive commercial program based primarily upon speed and low cost.

The execution of the program must be predicated on placing the problems in competent hands to make certain that the tools, equipment, and product will be characterized by basic simplicity, utility, and economy; and that the results will be orderly, efficient, and profitable.

The ascertainment lies in the hands of management and will have to emerge in the form of a conservative and stable policy if aircraft companies are to continue to exist profitably.

---

## Diesel Power of M.S. "Henry Ford II"

(*Continued from page 793*)

There are two Worthington air compressors which supply the air for starting purposes; the air is pumped into air bottles or chambers and used as needed; the air pressure in these bottles is constantly kept at 650 psi.

### DIESEL OPERATING SUGGESTIONS

A few hints on successful operation of Diesel engines follow:

1 It is important to keep the lubricating oil clean and free from water and dirt; also to keep the engine water jackets free from scale and grease.

2 Keep the piston clearances as specified by the engine builders.

3 A constant check of the exhaust temperature is essential. If it rises above normal it indicates excessive fuel consumption or improper timing and may cause considerable trouble.

Fig. 2 shows a set of indicator, compression, and valve-lift cards taken on the main engine of the motorship *Henry Ford II* on Lake Superior; ship loaded, 19-ft draft, strong head wind. The valve-lift cards were taken on 1 to 10 control for the front valves and 3 to 10 control for the back valves; Table 1 contains the data. Conditions of the run were as follows: Fuel pressure, 5000 psi; control on No. 7; engine revolutions, 82.4 per min; speed, 13.4 mph; fuel consumption, 140 gph.

TABLE 1 DATA FROM ENGINE-OPERATING CARDS

| | Indicated horsepower | Ignition pressure, psi | Valve open front | | Valve open back | |
|---|---|---|---|---|---|---|
| | | | B.D.C., deg | A.D.C., deg | B.D.C., deg | A.D.C., deg |
| No. 1 cyl.... | 812 | 509 | 20 | 26 | 20 | 26 |
| No. 2 cyl.... | 809 | 514 | 23 | 25 | 21 | 25 |
| No. 3 cyl.... | 789 | 514 | 22 | 25 | 20 | 25 |
| No. 4 cyl.... | 796 | 512 | 22 | 25 | 22 | 25 |
| Total........ | 3206 | | | | | |

$$\text{Fuel consumption} = \frac{140 \times 7.46}{3206} = 0.325 \text{ lb per ihphr}$$

# RESISTANCE WELDING *With* STORAGE-BATTERY POWER

By JOHN D. GORDON

GENERAL MANAGER, PROGRESSIVE WELDER COMPANY, DETROIT, MICH.

RESISTANCE welding has been recognized by the metalworking industry for some time as the simplest and fastest method of joining parts. Its use has been widely adopted for the mass production of identical assemblies in practically every industry employing steel fabrication. Recently the increased demand for high-production welding equipment led to the development of storage-battery-powered resistance welders to overcome the inherent limitations of conventional welding processes especially when applied to aluminum and its alloys.

### SPOT-WELDING ALUMINUM IS DIFFICULT

A simple spot weld is made by passing a heavy electrical current through metal parts while they are held in intimate contact. The heat for the formation of the weld nugget is generated by the resistance of the metal to the flow of electric current; being directly proportional to the square of the current, the electrical resistance of the metal (and the metal junction), and the time current is applied. The intensity of the current must be sufficient to fuse the nugget before the heat is conducted away by the surrounding metal and the dies. Since aluminum is a good conductor of both the electricity and heat, it is relatively difficult to spot-weld as compared to steels. It requires very high welding currents of relatively short duration.

It is possible to weld aluminum and its alloys with conventional a-c resistance welders, modified to deliver welding currents in the range of 10,000 to 30,000 amp. However, the power-line demands of such machines are excessively high and they operate at a very low power factor. A typical a-c aluminum welder has a demand of about 400 kva at 40 per cent power factor, lagging. It is infrequent that power supply is available for equipment in this power-demand range. Since most power rates are based upon a maximum-demand charge with a penalty for low power factor, the operation of such machines is costly, and the investment in plant necessary to provide heavy-duty power lines from the machine to the source of supply is often prohibitive. In many industrial localities the power facilities are not capable of doing the job at all.

### "STORED-ENERGY" WELDING MACHINES

"Stored-energy" types of welding machines offered a solution. Energy could be supplied to machines at a low rate, stored, and then delivered at a high rate for welding. Two types of stored-energy machines had been developed: One type makes use of direct current to build up an intense magnetic field in a specially designed transformer. When the current is interrupted the rapid collapse of the magnetic field momentarily induces a voltage which produces a high current in the welding circuit to produce a weld. The other machine type converts line power to a high direct-current potential to charge a bank of condensers. The discharge of these condensers through a transformer into the welding circuit produces the weld.

Both machine types are an improvement over the conventional a-c welders in that they can be operated on 3-phase supply with consequent reduction in power-line loads. Their power demand averages about one fifth that of the a-c welder. The control of the duration of the welding current is limited and the initial cost of this equipment is high compared with conventional a-c machines. The storage of energy is a part of the operating cycle of the machine; actual spot-welding rates usually do not exceed 80 spots per min.

The most obvious method of storing electrical energy of course is the storage battery. Energy can be supplied to it continuously at a low rate, stored for an indefinite period, and used as required. Battery chargers are widely available in package units. These have a high efficiency, draw a high-power-factor type of load, and are simple to operate. At one time the problem of interrupting the enormous low-voltage direct currents that are required in resistance welding seemed insurmountable. However, a common device, the carbon-pile rheostat, has solved this problem. The development of a form of this laboratory instrument adaptable to routine resistance welding has thus made welding with storage-battery power a practical industrial tool. As a result, incidentally, resistance welding has been freed from high-capacity power lines, permitting metalworking plants to be located in small towns and outlying districts, away from major industrial areas.

### DESIGN OF STORAGE-BATTERY-POWERED WELDERS

Storage-battery-powered welders are similar in design to conventional a-c resistance-welding machines. The essential difference is that a bank of storage-battery cells replaces the customary welding transformer. The mechanical operation of battery-type spot, projection, roll-spot, and flash welders, either stationary or portable, is the same as for conventional a-c type machines. Control equipment for battery welders such as timers, "heat" regulators, and contactors are simpler and easier to maintain than those for other types of stored-energy machines.

The flexibility of storage-battery welders seems to be unlimited. Their welding capacity can be extended merely by increasing the number of cells used and welding rates depend primarily upon the output capacity of the battery charger employed. The range of materials that have been successfully spot- and projection-welded extends from very thin-gage mild steel, and stainless steel, to heavy-gage ($^3/_{16}$-in.) aluminum-alloy sections. Although the full range of possibilities of flash-welding with battery power has not been determined as yet, exceptionally good flash welds have been made on aluminum and other metals having a narrow plastic range, materials heretofore considered unsuitable for flash-welding.

A typical battery-powered welder installation is shown in Fig. 1. This rocker-arm-type machine houses 12 storage cells. At the left is the charger unit with an electronic timer mounted at the top. This welder makes 240 spot welds to assemble the part shown from "laminated" thicknesses of $^1/_8$-in. structural steel. Approximately six assemblies are completed per hour.

---

Contributed by the Production Engineering and Metals Engineering Divisions and presented at the Semi-Annual Meeting, Detroit, Mich., June 17–20, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

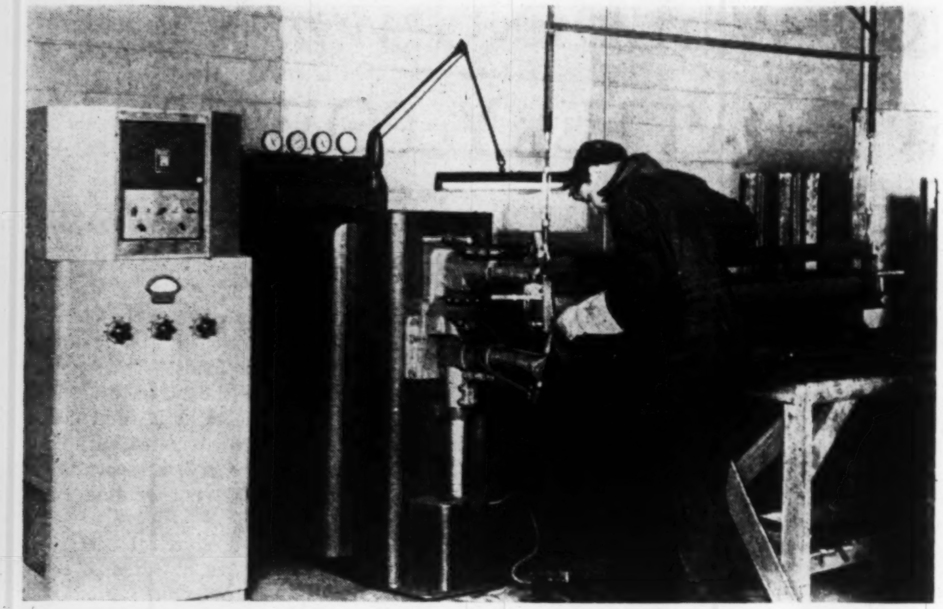


FIG. 1 TYPICAL STORAGE-BATTERY-POWERED RESISTANCE-WELDER INSTALLATION

(Approximately 29,000 steel spot welds of $^1/_8$ in. are produced each 20-hr day. Power demand is only 26.7 kva, balanced on three phases. Power factor in 85 per cent.)

Total output for two 10-hr shifts is around 29,000 welds. Welds are closely spaced in rows, permitting a weld to be made every $^1/_2$ sec by automatic machine-cycling. Operating 20 hr out of every 24, this machine has a higher production than the 150-kva conventional a-c welder it replaced. It supplies 20,000 amp of welding current with a total power-line demand of only 26.7 kva, or less than $^1/_5$ that of the comparable a-c welder. In addition, the load is continuous and balanced on all three phases of the power supply at approximately 85 per cent power factor, while the a-c welder drew its entire load from one phase at approximately 40 per cent power factor.

### THE WATER-COOLED BATTERY

In welding service it is desirable to maintain as high a charging rate as possible in order to obtain the maximum output with the least number of batteries. The effective capacity of a storage battery is limited, however, by the temperature rise of the cells during charging and discharging. The use of a new type of battery, designed originally for maritime service, plus the addition of an internal water-cooling circuit in the battery has increased the practical capacity several times over that of conventional batteries. In addition, the life of the battery is increased and maintenance reduced.

Cooling of the cells is accomplished by use of some 50 in. of $^1/_4$-in-OD lead tubing in the electrolyte near the top of the cells, Fig. 2. Tap water is circulated through the tubing at a rate determined by the requirements of the operation. The lead tubing is separated from the plates by insulators of special hard rubber, and from contact with the terminals by enclosing the tubing in rubber sleeves at these points. Positioning of the cooling circuit near the upper surface of the electrolyte also materially reduces the excessive loss of electrolyte associated with uncooled batteries.

Precise control of battery voltage during charging greatly reduces the generation and escape of hydrogen even with the welder under heavy-duty operation.

Microporous separators retard the loss of active material by the plates. Deep sediment receptacles at the base prevent the normal accumulation of sulphide from shorting the plates. Each cell is provided with six heavy terminals in place of two to reduce the voltage drop of the cell to a minimum and to provide ample capacity for an average of 7000 amp normally delivered by each cell during welding. Even at high-duty-cycle service the cells remain cool.

The cells are "banked" as required for the specific welding service, that is, two or more cells are connected in series to provide the proper welding voltage, usually 4 to 10 volts, and a sufficient number of cells are connected in parallel with these to supply the amount of welding current needed. Banks of 6, 8, 12, and 16 cells are common. The size of the battery selected for a particular welding operation usually results in a reserve capacity sufficient to make approximately 2000 welds in the event of power-supply failure.

### THE CONTACTOR-CONTROLLER

The construction of a typical heavy-duty contactor controller, capable of making and breaking welding currents up to 40,000 amp continuously at 200 times per min is shown in Fig. 3. Three circular copper-alloy plates, with connection terminals, support four carbon-graphite contact disks.

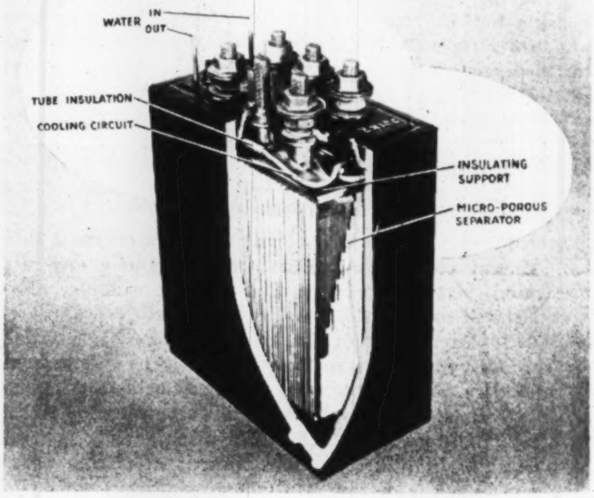


FIG. 2 CUTAWAY SECTION OF A WATER-COOLED STORAGE CELL DEVELOPED BY AUTHOR'S COMPANY

(Note the six heavy terminals for conducting welding currents up to 7000 amp per cell.)

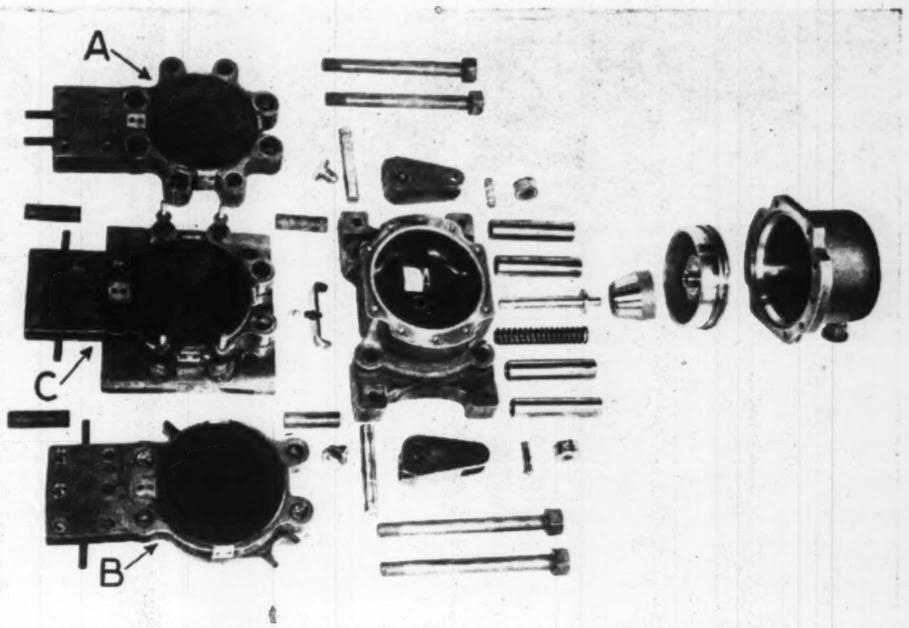


FIG. 4 DISASSEMBLED VIEW OF A CONTACTOR CONTROLLER AFTER 1,000,000 WELDS
(Note the original toolmarks on the carbon-graphite contact surfaces indicating the absence of erosion.)

Mounted below an air cylinder, the upper plate is connected to the piston through a cam linkage. The disassembled view, Fig. 4, shows the two carbon-disk contact surfaces of the central plate and the single contact surface of the upper and lower plates. When these parts are assembled with springs and guides the contact surfaces are just barely separated (0.090 in. maximum). When the contactor is operated the carbon disks are forced together under a pressure of approximately 1000 psi, amounting to about 50 tons pressure on one-size unit.

It will be noted that the four contacting surfaces offer two paths for the flow of welding current, namely, from the central plate to both top and bottom plates. This cuts the voltage drop of the contactor to half, compared with using only two plates.

When pressure is first applied to the plates the resistance to the flow of current is extremely high. As applied pressure increases, the resistance of the carbon disks to the flow of current decreases rapidly until under full pressure there is practically no resistance, and full welding current flows through the contactor.

To stop the current flow, air pressure is removed, allowing springs in the assembly to separate the plates. Upon release of the contacting pressure the resistance of the plates increases rapidly with the decrease of pressure so that at the instant the plates separate there is practically no remaining current to be interrupted. Proper selection of the carbon-graphite material and the thickness of the disks provides the desired pressure-resistance characteristics.

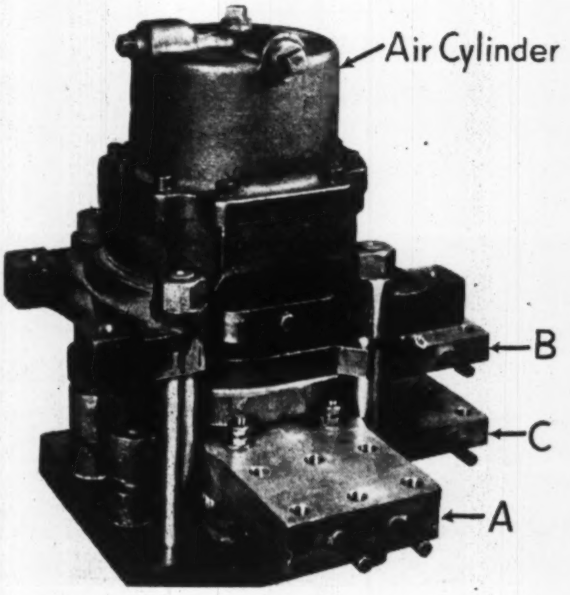


FIG. 3 HEART OF THE STORAGE-BATTERY-POWERED WELDER IS THE AIR-OPERATED CONTACTOR CONTROLLER
(The unit shown is capable of interrupting up to 40,000 amp without arcing.)

No arcing occurs at the contacts. The only visible indication of current interruption is the presence of occasional minute incandescent particles of carbon dust that glow momentarily between the separating contact surfaces. Water-cooling circuits within the copper mounting plates carry away the heat generated, permitting continuous recycling all day long.

### WELDING-CURRENT REGULATOR

Welding current can be controlled by the arrangement of battery connections in steps of approximately 2 volts, but this method does not provide the precision required by most welding operations. This is particularly true for the welding of thin sections of steel or of aluminum and other materials having a narrow plastic range. Wide-range stepless adjustment of welding current is provided by means of a copper-covered cast-iron rheostat interposed in the welding circuit, Fig. 5. Movement of the sliding-contact block along the U-shaped member introduces more or less resistance into the circuit as required. Adjustment range is usually from 50 to 100 per cent of maximum current. A quarter-turn of the adjustment arm locks the contact block in place and also indexes it on a graduated scale for calibration or resetting reference. Both resistor element and contact block are water-cooled to maintain constant current regulation over a wide range of welding rates.

### WELDER-CONTROL SYSTEM

The mechanical operation of storage-battery-powered welders is similar to that of conventional a-c welders. Fig. 6 shows a schematic layout of a typical rocker-arm-type machine. Adjustable electrode pressures provided for squeeze, weld, forge, and hold intervals are supplied by a pneumatic system. Two solenoid-operated valves admit air to either end of the

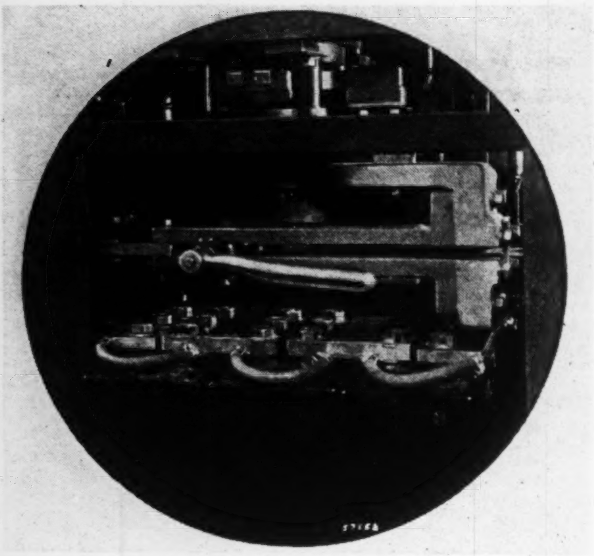


FIG. 5 WIDE-RANGE STEPLESS WELDING-CURRENT REGULATION IS PROVIDED BY A SIMPLE CAST-IRON RHEOSTAT

(Adjustable-arm indexes on a graduated scale are for calibration and reference.)

rocker-arm air cylinder. The upper valve (normally open) separates the electrodes. The lower valve (normally closed) provides squeeze, weld, hold, and differential pressures when open. Closing the upper valve while the lower valve is open provides forge pressure, exhausting the upper cylinder. The timing and sequencing of the valve movement is by a simple electronic timer and two-stage foot-operated initiating switch. Additional controls include movable-arm retraction by means of an air cylinder and toggle linkage in the connecting rod, and a light electrode pressure for point dressing. This is supplied by a low air pressure acting on the main cylinder piston when the upper air chamber is exhausted. The contactor is also operated by an air valve controlled by the timer.

A simple differential-cam-type timer is often used in place of the electronic timer shown. The cams are mounted on a common shaft for direct operation of the air valves. A single-revolution clutch, controlled by the initiating switch, engages an adjustable-speed drive to rotate the camshaft each welding cycle. Interest has been shown in this type of timer because its operation is more easily understood than that of an electronic device.

### BATTERY-CHARGING CONTROL

Three-phase full-wave dry-disk-type rectifiers and specially designed controls are employed to convert the usual factory

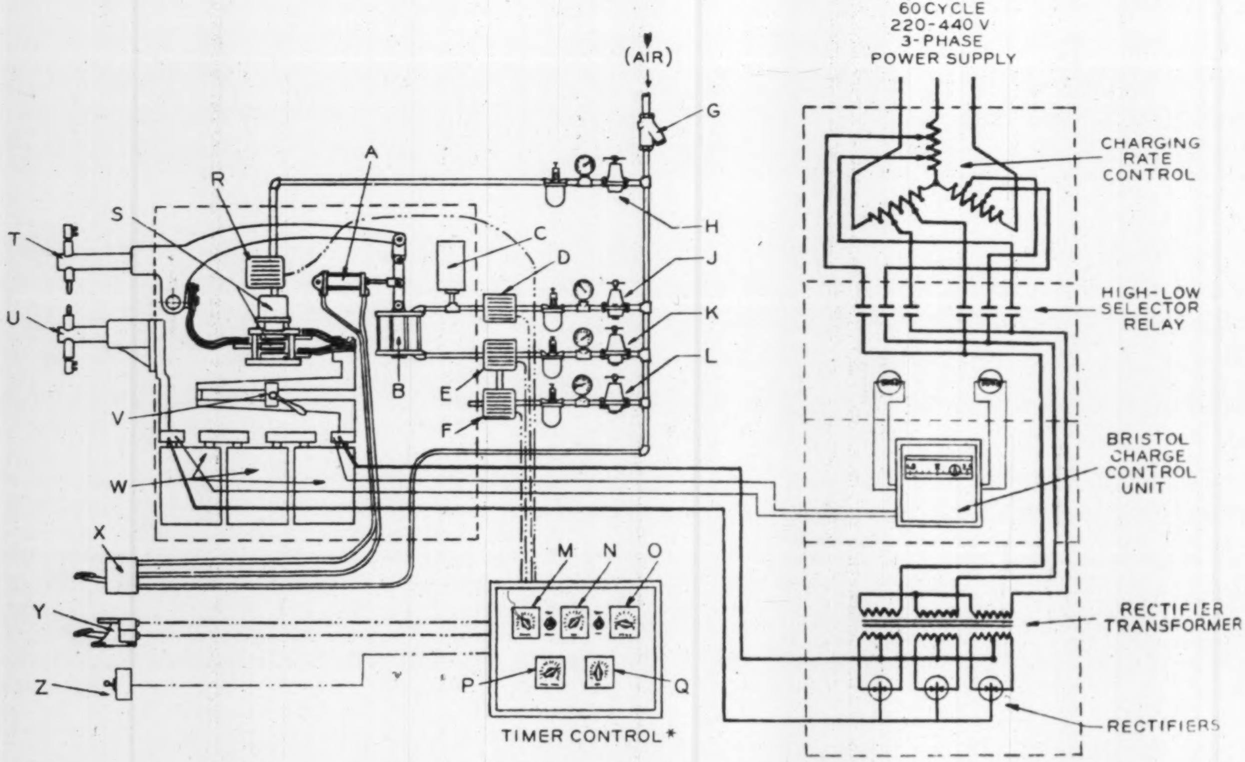


FIG. 6 SCHEMATIC DIAGRAM OF A TYPICAL BATTERY-POWERED WELDING MACHINE AND CHARGER

A Retractable stroke cylinder
B Main operating cylinder
C Air tank reservoir
D NO solenoid air valve
E NC solenoid air valve
F NC solenoid air valve
G Main air-line strainer
H Contactor air regulator
J Opposing-pressure regulator
K Welding-pressure regulator
L Point-dressing-pressure regulator
M Squeeze-period dial
N Weld-duration dial
O Forge-delay dial
P Hold-period dial
Q Off-period dial
R Contactor air valve
S Battery contactor
T Movable rocker arm
U Stationary lower arm
V Welding-current regulator
W Group of batteries
X 4-way foot-operated air valve
Y 2-stage foot-operated switch
Z Point-dressing switch
* Varies with type welder

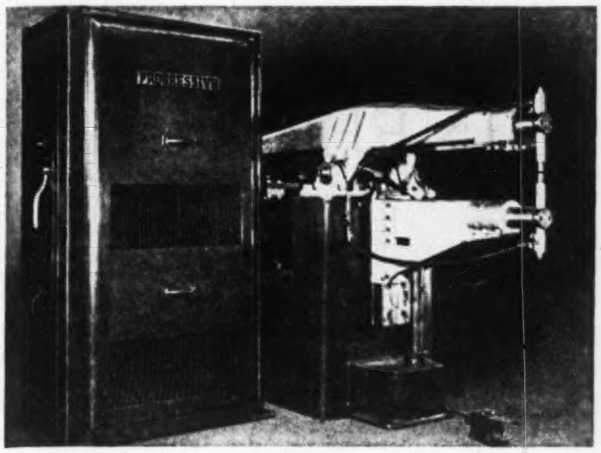


FIG. 7 POWER SUPPLY OF THIS STORAGE-BATTERY WELDER IS HOUSED IN A SEPARATE "POWER PACK"

(Such units can be readily connected to a wide range of machines to provide increased welder flexibility.)

alternating-current power to direct current and maintain the storage cells at the proper charge. The charger and controls can be assembled as a separate unit, or one or more components can be housed within the welder, Fig. 7. This type of charger is fully automatic and requires very little attention except when changing welding operations.

A tapped autotransformer and two selector switches provide a wide range of current adjustments for both "high" and "low" charging rates, Fig. 6. The low charging rate supplies sufficient energy to the cells for the usual welding rates. When the welder is operated at high duty cycles the high rate is automatically selected. The control is essentially a sensitive voltmeter connected across the battery, operating a simple electronic circuit to maintain automatically the battery at a preset voltage. The usual practice is to limit the variation of potential of the cells to between 2.07 and 2.2 volts. This is a tolerance of approximately 6 per cent which provides satisfactory regulation for most welding processes, and is in fact, considerably better than the regulation usually obtainable on a-c welding machines operated in conjunction with other machines on the same low-voltage feeders. Although highly sensitive, heavy damping prevents demands of a single weld from starting the charger.

The use of storage-battery power for resistance-welding eliminates many of the causes of poor and inconsistent welds resulting from a-c welding current. Continuous unidirectional power is supplied to the weld instead of the usual power pulses which rise from zero to maximum in each direction and reverse 120 times per sec for 60-cycle service. Such alternating current induces some eddy currents in the mass of the workpiece. This of course is a loss and does not contribute to the formation of the weld. The amount of this loss is proportional to the mass of the workpiece enclosed by the welding loop, so that successive weld nuggets become smaller and smaller as the workpiece is fed into the machine. For battery welders variations of weld strength due to eddy-current losses are negligible even where large workpieces must be placed in the welder throat.

### CONCLUSIONS

Battery power provides a large reserve of power capacity that is not affected by fluctuations of power-line voltage due to the operation of other electrical equipment on the same circuits. It is often necessary to interlock the controls of a group of a-c welders to prevent simultaneous operation and the resultant interference with the production of identical welds. This is unnecessary when battery welders are used.

It is often desirable to house the batteries, current regulator, and contactor controller in a separate "package" unit to provide additional flexibility for battery-powered welding equipment. The power pack, shown in Fig. 7, can be connected to any type of battery welder, and other power packs can be connected to the same machine to increase its welding capacity in steps of approximately 25,000 amp of welding current. Thus welding equipment need no longer be confined to a narrow range of utility. The interchange of machine and power packs can provide almost unlimited conversions in the event of product redesign or major engineering change.

Fig. 8 shows a battery welder at the Aluminum Goods Manufacturing Company, Manitowoc, Wis. This group of six welders was used for assembly-welding containers for the storage of rocket bodies. The material is 0.081-in. 3 S aluminum. Eighty-four spot welds are required to assemble the boxes and attach the handles and locking devices.

Power facilities were not available for the use of other types of stored-energy welders. This company estimated that the cost of a condenser-discharge-type welder installation would have been 40 per cent more than the battery-power welding equipment installed.

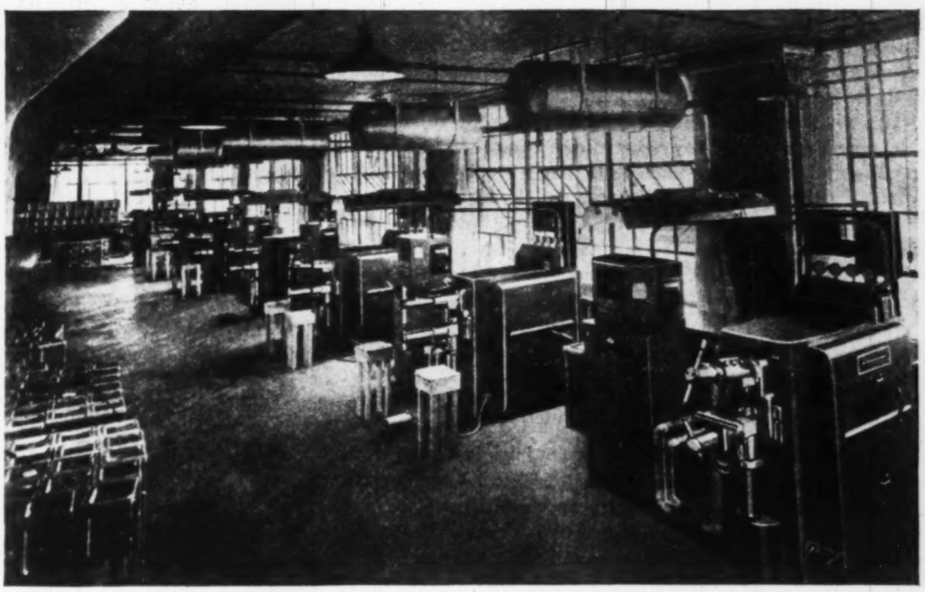


FIG. 8 A GROUP OF BATTERY WELDERS SPOT-ASSEMBLY-WELDING 0.081 TO 0.081-IN. 3S ALUMINUM ROCKET-BODY CONTAINERS AT ALUMINUM GOODS MANUFACTURING COMPANY, MANITOWOC, WIS.

# MANAGEMENT RESEARCH *and* THE ENGINEER

By WILLIAM E. HILL

TURCK, HILL & COMPANY, INC., NEW YORK, N. Y. MEMBER A.S.M.E.

THE use of research in business administration is opening new horizons for the application of engineering principles. There is a demand by management for scientific fact gathering in the development of progressive industrial programs.

Management can no longer afford many opportunities to speculate on its decisions. Taxes and other fixed costs of doing business do not permit such speculations. Management must be close to being right the first time. It must have facts and it must know how to use them.

The Metropolitan Section of The American Society of Mechanical Engineers made a survey in June, 1945, of the management subjects of primary interest to its members. Management research was the first choice expressed in this questionnaire.

This interest of the members of the A.S.M.E. in management research is a strong indication of the need of analysis of fundamental questions of corporate policy.

### DEFINITION OF MANAGEMENT RESEARCH

In the growing departmentalization of effective business administration, the function of research in corporate policies and practices becomes specialized. It is this activity, in its comprehensive sense, with which the engineer is directly concerned.

Originally devoted to specific subjects such as economic analysis, trade analysis, and other applications, research in management is now being directed more and more to the formulation of basic management policies. In many cases, so-called business or commercial research is still limited to a departmental function. Some companies develop the habit from such departmental procedures, eventually applying these techniques to the broader problems of business administration.

There has been a definite lack of agreement on the definition of management research, despite the increasing general interest in the subject. It is recommended that consideration be given to standardization of the following definition: "Management research is the investigation, analysis, and application of essential information for effective business administration, leading to the establishment of fundamental corporate policies and practices."

As in research devoted to the natural sciences, there are two main objectives of management research:

1 The identification of basic principles.
2 The application of these basic principles.

Without such fundamental research business becomes routine—habit-directed. The momentum of the past decisions and accomplishments of management personalities can carry a company for many years, like the one-horse shay, until an accumulation of external and internal circumstances creates a collapse.

### HISTORY OF MANAGEMENT RESEARCH

Research in fundamental questions of business administration is a relatively new technique. All company units with comprehensive programs have been established since 1920. A major interest in the subject has developed only in the last fifteen years. The growth in its use is still in the early stages.

Du Pont founded its trade-analysis section as early as 1896. In 1906 the first general economic analysis was conducted for a business concern. Marketing research units of manufacturers appeared in 1917, an example of which is the customer analysis originated by the Vacuum Oil Company. Recommendations for the commercial use of applied psychology were made in 1921. The application of statistical methods to tendencies of per capita sales developed around 1925.

In other words, management research of a comprehensive nature grew out of such applications in a specific department of a business. It spread until it became the habit of a company to develop its major corporate programs from an objective and factual standpoint.

Progress is being made in the use of management research. The adolescent stage has been reached and, while it is still immature as a general management practice, it is becoming possible to measure the progress in this field.

An investigation of the National Industrial Conference Board in 1940 disclosed the limitations up to that time in the use of management research. Less than 40 per cent of 385 industrial concerns compiled data for their own industry. And only 38 per cent prepared reports on general business prospects.

In the specific field of market research, the Department of Commerce made a survey of 188 manufacturers in 1939. By that time, 73 had established their own units for which the average expenditure was $29,000 a year or $1 for each $4000 of net sales. A similar survey by the National Industrial Conference Board in 1945 also disclosed the increasing interest in the use of research techniques in this specific field, but continued to show that the subjects of departmental research are not primarily the basic questions of corporate policy facing a company.

### SCOPE OF MANAGEMENT RESEARCH

Management research is beginning to penetrate every phase of business activity as a foundation of policy determination. Progress is being made in the analysis of the primary functions of distribution, manufacturing, personnel relations, and public relations, and of general economic conditions and other business interests.

In 1941 the National Resources Planning Board ranked such research in 33 leading companies. Distribution received first mention, followed by general economics. Personnel research was found to be developing most rapidly. While distribution may be receiving the most attention in the application of management research, it is known from personal experience[1]

---

Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., Nov. 26–29, 1945, of The American Society of Mechanical Engineers.

[1] "Scientific Methods of Distribution," by Fenton B. Turck and William E. Hill, Mechanical Engineering, vol. 66, 1944, pp. 183–191.

how relatively little fundamental work is actually being done in this field. The potential is tremendous in it and in other basic elements of business administration.

### THE NEED BY MANAGEMENT FOR RESEARCH IN BUSINESS ADMINISTRATION

The complexities of present-day management are forcing a wider and more specific analysis of the problems that are faced by corporate administration. It is by no means a widely accomplished practice, with many a management relying on the old "hunch and heave" procedure.

There are many companies, large and small, whose managements resent the implication that factual analysis is needed to support their individual judgment. This is human but shortsighted. The old aphorism, "look before you leap," was never more applicable than today. Business is faced with a definite challenge of the need for more scientific "looking."

On the other hand, many of the practices of research in business administration are not grounded on scientific fundamentals. Also, the personnel selected for the task are often inadequately trained for the development of the required facts or the practical application of such facts to the immediate and future problems of corporate policy. In many cases, experience with superficial practices and inadequate personnel have resulted in deterring the continued use and development of management research in companies that were originally willing to experiment with it.

### NEED FOR ENGINEERS IN THE EXPANDING FIELD OF MANAGEMENT RESEARCH

The engineer has a great opportunity in the expanding field of management research. He must, however, be equipped to apply his engineering training to this specialized field.

As a specific example, the Newark College of Engineering inaugurated a series of conferences in 1945 on "Finding and Using Distribution Facts—Engineering for Improved Distribution."[2] Active businessmen in many diversified activities paid money and time to attend seven sessions of this seminar.

The engineering schools, societies, and related groups have the responsibility of helping prospective and actual engineers to apply their principles in the field of management research. Industry will benefit by the services that can be rendered.

---

[2] "Distribution and Employment," by William E. Hill, *Distribution Age*, January, 1946, pp. 31–32, 88–89.

---

# RESEARCH *for* TOP MANAGEMENT

BY J. P. KOTTCAMP

VICE-PRESIDENT, JOHNS-MANVILLE CORPORATION, NEW YORK, N. Y. FELLOW A.S.M.E.

WORLD War II demonstrated beyond all doubt that our country leads the world in engineering genius. A production job, unparalleled in history, was accomplished. It is common knowledge that this outstanding feat had as much to do with winning the war as any campaigns on the battle front. By that I do not mean to detract from the achievements of the valiant men and women in the armed services. The courage they displayed and the sacrifices they made will not be forgotten by a grateful America. Nonetheless, it was the men on the production front who made their victory possible. And the brunt of the planning behind this mammoth production job was borne by our engineers. Through their efforts industry reached unbelievable heights and came forth with amazing results. Our engineers pitted their skills against the best engineering brains of the enemy and defeated him through production and with devices that were almost uncanny and fantastic in their operation.

The problems of winning the peace will be no easier than the problems of winning the war. Here again the engineer will be called upon to make his contribution. How great a contribution he will make will depend entirely upon the opportunities afforded him and the opportunities he creates for himself.

The common picture of the engineer is that of a man poring over a blueprint; building a gigantic dam or supergenerator; examining a fractional distillation tower. He has made such a reputation for himself in these activities that little thought is ever given to the wider uses of his training, his analytical mind, and his capabilities. For the most part these talents have been confined to the purely material side of mechanics, steam, electricity, physics, chemistry, and related fields.

But engineering is more than that. Despite the emphasis placed on the material side of engineering let us recall its age-old definition. It is described as: "The art of organizing and directing men, and of controlling the forces and materials of nature, for the benefit of the human race."

"Three elements are involved. One deals with men, the second with forces and materials, the last is the ultimate purpose." The engineer has yet to come into his own to embrace all of these aims of his profession and to assume the responsibilities which should be his by virtue of his background. Given the opportunity, more engineers can be of greater assistance to top management. If allowed a broader approach the engineer could utilize his peculiar talents to the fullest. Specifically he could be of invaluable assistance to top management in the field of research.

### THE TRAINED ENGINEER IN RESEARCH

Now what do we mean by research? It is not the limited meaning usually given it when applied to a research laboratory or a division of a company. As Dr. Kettering, head of the research department of General Motors says: "For some reason, that word 'research' has come to be surrounded by a good deal of meaningless mystery. If I can accomplish nothing else, I would like to dispel some of that mystery. Research, after all, is nothing but prospecting for knowledge. Whenever someone sets out on an organized program to uncover new knowledge about a subject of which he knows very little, he is engaging in research. There is nothing mysterious about it, nothing highbrow. It is the most natural thing in the world."

Continues Dr. Kettering: "One of the great troubles with research as it is usually carried out today is that it is too impatient to get tangible results. What we need is more analysis of fundamentals and less invention for invention's sake." That is where the trained engineer enters the picture. He is at heart

---

Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., Nov. 26–29, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

a prospector for knowledge. Because of his training he is guided by sheer logic and may be counted upon to gather, evaluate, and collate the thousands of facts that enter the industrial picture and present them to top management for decisions of policy.

At present, research and engineering, as they are popularly interpreted, are narrowly confined in industry. You are familiar with the forms of research. There is the practical research dealing with quality, new products, and new developments. And there is the abstract or pure research dealing with fundamental principles which may develop improvements or by-products of value to mankind.

These forms of research are limited basically to the material, the physical products of industry. For a number of years top management has used these forms of research for the solution of some of its problems and with notable success. The day is over when the chairman of the board or the president can haphazardly decide to do this or that. Scientific research has taken the place of personal opinion. And it has expanded considerably. The National Research Council reports that in the year 1920 there were 300 industrial companies with research departments. These companies employed 9300 persons. By 1940 there were 2350 research departments employing 70,000 persons, with an estimated annual expenditure of 300 million dollars. That is an encouraging trend.

But research has been limited. If top management has discovered that research has been so successful in the development of new products and facilities, why not broaden its field in industry? For example, when the automobile industry was in its infancy the main job was to make the motor run. The scientific approach, the best in engineering brains, was called upon to tinker with the motor until it ran. Without the motor there could be no automobile. But now is the time for top management to apply research to the rest of the automobile, to the chassis, to the windshields, to the supplier of parts, to the workers who make the automobile, to the operators, in short, to anything and everyone connected with the manufacture, maintenance, and operation of the automobile.

That is a responsibility of management, to broaden the field of research to embrace every phase of its activity. For in the complex industrial society under which we now live management no longer represents as formerly a single interest. Increasingly it functions on the basis of a trusteeship, endeavoring to maintain a proper balance of equity between four basic interlocking groups. These are the stockholders, the job holders, the customers, and the public.

It has been only in recent years that the interdependence of these different social groups has been recognized. But this interdependence is far from being thoroughly understood. Yet the mutual obligations of these groups must be clearly perceived if society is to progress. The job holder cannot produce without tools, material, and money. The stockholder cannot profit without the time, the ideas, and the dynamic energy of men supervising the power now harnessed to the machine. None can have except as together all produce. For labor can prosper only as industry prospers.

### ECONOMIC PRODUCTS AND SOCIAL FORMS

To maintain a proper balance between the various groups directly and indirectly concerned with its operations top management must tackle more of its problems more scientifically. These problems may be divided into two basic groups. As Dr. Claude Robinson of the Opinion Research Corporation has pointed out, they are *economic products* and *social forms*.

On the product side we invent, manufacture, advertise, sell, and distribute. On the institutional side we also invent or manufacture organizational devices, advertise them, tell our people of their advantages.

Social forms, as defined by Dr. Robinson are simply relationships between people that recur and form observable patterns. They are the relationships that constitute the organization of economic society. Incentive discounts for dealers, open house for the community, the eight-hour day and 40-hour week, loan systems for tiding workers over slack periods are all examples of the manufacture and distribution of social forms. Other examples include more leisure for all, a decent living for all, the annual wage, hospitalization, higher wages, unemployment insurance, pleasant working conditions, retirement benefits, and so forth. Note how all of these items bear upon human relations.

Explaining that business has always prospered under competition, Dr. Robinson goes on to say that the steps for the solution of the competitive problem in the area of social forms are exactly the same as they are in the area of product competition. The economic product competes with products of other manufacturers, co-operatives and government plants. Social forms also compete with other manufacturers in the labor market, with labor leaders for more of the company's earnings and greater security and with political leaders, particularly those who espouse social leadership, government ownership of the means of production.

You are all very familiar with product competition. But I think it would be worth while to examine more closely some of the competitive aspects of social forms. During the past fifteen years this field has been exploited by the social planners to a greater degree than at any time in our history. The planners have used every method at their command to further government control of industry with the ultimate aim of setting up some form of state socialism. It is not for me to question their motives. Admittedly some of them may be selfish. Some may be idealists in quest of the illusory pot of gold at the end of the rainbow. But there are among the social planners those who sincerely believe that our system of free enterprise has failed and that if mankind is to benefit there must be a change. They have used social forms to set up competition between government and industry.

These social planners and their schemes cannot be dismissed with a categorical denial. Rather, it is up to industry to prove that it can do a better job without governmental intervention. Some union leaders have adopted the scientific approach to the social forms which they are advocating. Recognizing the truism that there is no substitute for cold facts upon which to base a course of action, they have marshaled the best of talent in many fields to keep them informed. They have developed a habit of scientific thinking which has aided them on numerous occasions to present their case thoroughly and successfully. Industry, too, must develop this habit of scientific thinking in the field of social forms. There is a crying need for it. Economic and social pressure is demanding it.

### ECONOMIC AND SOCIAL DEMANDS FOR SCIENTIFIC APPROACH

Years ago there were no such economic and social demands on top management. Accordingly it endeavored to do its own research, if it did any, in this field. But now as a result of the growth of labor unions, the vastly changed social outlook, and the increasing activity of competition, top management sorely needs this type of scientific approach to its problems. We might well ask ourselves if this change in public sentiment has been due to smart propaganda on the part of labor leaders, poor judgment on the part of management for not having done a better public-relations job, or is merely a symptom of the changed social outlook. The research engineer can be of tremendous help in assembling data that would answer these questions. There is a crying need for scientific investigation of the conditions surrounding manufacturing plants, with particular reference to the attitude of the community toward the local industry or company.

This habit of scientific thinking is equally applicable to both large and small companies. In the struggle for survival a company cannot operate on opinion and whim. We are living in a scientific age and must use the scientific approach in every possible field. By adopting the scientific approach, through engineering research, top management should be able to solve the problems both of products and social forms and to co-ordinate the many diverse phases of a modern corporation for the greatest good of the greatest number.

The complex departments of a large corporation—sales, production, finance, research, industrial and public relations, engineering—cannot be independent, each reporting separately to one superior. All are dealing in one way or another with products and social forms. Each is dependent on the others. And all have a direct bearing on the stockholder, job holder, the customer, and the public.

Top management is responsible for seeing that all departments are co-ordinated in carrying out current operations as well as in contributing to the long-range planning which is so vital to the life of any business. To accomplish all this requires a well-knit organization in which everyone knows what is expected of him and does it, and in which overlapping of functions are minimized, duplication of effort eliminated, and specific responsibilities for specific jobs clearly designated. The formation of such an ideal organization requires the analytical mind, the type of mind that the experienced engineer possesses. I see no reason why it is not possible to use an engineering approach to an entire organization. An objective, fact-finding research organization to evaluate all of the many activities of a corporation should be of great assistance to top management in making decisions.

To be successful such an organization or such an individual in a smaller company should be on a par with the major divisions of a company and report directly to the president. It should have its fingers on the pulse of the company at all times. Too often many a good idea has been rejected by top management because its method of presentation has been slipshod, weak, carelessly thought up, or too cluttered with nonessentials that obscure the crux of the problem. Then again, much time, labor, and thought are devoted to the study of a problem which bears only an insignificant relationship to the full operations of the company. A proper research department would have the advantage of being acquainted with the basic problems of the company and would be able to sift the wheat from the chaff and submit the significant facts to top management. Moreover, top management would be receptive to such a thoughtful, logical, and carefully prepared presentation. Obviously the cost of such an organization will vary with the size of the company. But no matter what the size, top management can have this type of service.

### THE ENGINEERING TECHNIQUE IN SCIENTIFIC ANALYSIS

If the company is large, it can well afford a staff organization whose primary function would be to carry on this management research. For the small concern with less-complex problems, it seems reasonable to assume that there should be an opportunity for at least one engineer who is capable of handling this scientific analysis. In those cases where neither the large nor the small organization deems it advisable to have its own staff engineers, there are now many consulting engineers equipped with experts to do this type of management research.

There seems to be a wealth of opportunity in the sales field for such a fact-finding organization. The engineer has developed scientific principles for efficient production. Why can he not develop scientific principles for more efficient distribution and for establishing potentials for consumption?

Perhaps it may seem unorthodox to assign a research engineer to problems in the financial department. But here we are dealing with cold facts and figures, the lifeblood of the true engineer. His objectivity, his prospecting for knowledge, can undoubtedly be of assistance to top management in this field.

These departments—sales, production, finance, research, and engineering—deal for the most part with the purely material or product side of industry even though the human factor is deeply ingrained in all of them.

For the sake of simplification I am grouping the human factor under the heading of social forms, as Dr. Robinson has expressed it. Only in recent years has top management taken full cognizance of the fundamental importance of human relations and has attempted to recognize it through the formation of industrial and public relations departments as well as through the indoctrination of executives and key employees. We are now living in an age where the human factor is a definite responsibility of top management.

### PROBLEMS FOR ENGINEERING RESEARCH

From what I have said about the cold, calculating, and analytical nature of the engineer it might seem that he would be quite out of place in any field where the human equation is so important. Happily the reverse is true: Just as the engineer studies the mysteries of electronics, the phenomena of the atom, and the possibilities of jet propulsion, so can he view the human equation as another problem in variables that must be analyzed. Perhaps engineering research may be in a position to solve some of the rather vexing and complicated problems of the day.

One of our biggest problems is to find a common ground for labor and management. Name calling will serve no purpose. When all is said and done labor is interested in being assured of a decent living and job security. Management must make a profit to continue to remain in business and reimburse stockholders who have invested in a company. And the consumer wants quality goods at low prices. Would a broadening of the scientific approach to management help to solve this problem? It seems likely that it would.

In the old days many factories, most of them in fact, were operated with no thought of the individual's security. The number of orders received each day determined the length of time the factory would run. The employees had no security. Until the orders were received they never knew if they were going to work. This question of continuous employment is one that still bedevils industry. And it is interwoven not only within every activity which touches upon a corporation but within society as well. Planned production by top management can be made possible only through a constant demand for goods. And this can only be created through stimulation of consumer desires, sound sales forecasting, and production planning.

It took many years before the present white-collar jobs were put on an annual salary basis. Through sound research by management will it not be possible to bring this about for hourly workers? Here is a problem in social forms for engineering research and top management.

With the current unrest and uncertainties, and with the resulting unemployment and delays in shipments, much valuable time is being lost in making the transition to a peacetime economy. In effect we are in a state of suspended animation. We cannot move forward and we have no intention of moving backward. We can only hope that an equitable solution to this turmoil will be found and that we are simply going through the birth pangs of a new and greater era of prosperity. And we can console ourselves with the fact that wars are usually followed by periods of unrest and that the present chaotic situation is no exception. Unfortunately, consolation is no solution and I am sure that it will never be found in the engineers' handbook.

But these trying times, with their manifold problems, should not deter management from future planning or from being ready to put into effect plans already formulated to expand facilities for the manufacture of new products, to broaden markets, and to increase efficiency in distribution of products. Here again there is a place for the engineer at the side of top management. The design and construction of new manufacturing facilities, the location of sites suitable for the company's needs are matters which require the ingenuity of the clever engineer and which involve painstaking research.

From what I have said it may appear that I have envisioned the engineer who is handling research for top management as omniscient and omnipotent. I have not meant to create that impression. In the final analysis this engineering research, this prospecting for knowledge is nobody's monopoly. It is not necessarily true that because a man has obtained an engineering degree, he has an engineering turn of mind. There are many men with analytical minds who had no formal engineering education. But the schooled engineer has this advantage: He is thoroughly grounded in fundamentals and principles and has the ability to obtain and compare facts with these principles. As a result of this background he is in a position to present recommendations based solely on facts and not on opinions.

Nor is management research itself infallible. As Wiren and Heyel[1] point out. "Management research cannot prevent errors in management any more than a fire-alarm system can prevent a fire; but, like the alarm, it can warn of the danger early enough for the situation to be brought under control. In addition, like the centralized board of a far-flung alarm system, it can indicate the specific point where trouble is brewing."

### OPPORTUNITIES FOR MEN OF VISION

In this connection, research engineers, as well as top management, should be men of ability and vision. Without these traits they would bog down of their own inertia. They would become set in their ways and would soon be far behind in the competitive race.

The man of vision is the man of optimism. He does not admit that a thing is impossible. He is not easily discouraged. He forges ahead, despite the obstacles and ofttimes in the face of ridicule. And he is eternally dissatisfied with things as they are.

Without men of vision the world's clock would have been turned back centuries ago. In our own day we can see what men of vision have accomplished. As we witness the wonders of science and industry which are being unfolded before the eyes of our generation every day, he would be a rash prophet indeed who would predict a pessimistic future for mankind.

On the other hand some of you engineers may be pessimistic about your own futures and may have become discouraged because top management has not given due consideration to some of your reports. But you should not be discouraged. If your ideas are good they will be accepted when properly presented and if you have the persistency to seek out an opportunity to get them a fair hearing.

I, for one, am confident that there are great opportunities ahead for the engineer who devotes himself to this type of analytical work and who approaches management research with the engineering type of mind. With his ability and vision he can find an excellent place for himself in an industrial organization. Top management needs scientific research and it is up to the engineers to accept the challenge brought about by the modern demands of the public for economic products and social forms.

In closing I would like to leave with all of you a thought I culled from "New Strength for New Leadship," by Erwin H. Schell[2] of the faculty of the Massachusetts Institute of Technology: "For men of talent, final years should be those of greatest effectiveness, influence, and enrichment. Then will be the time when the powers of judgment should be in their prime, when wisdom should reach its zenith; when untrammeled outlook can most clearly see the truth undistorted by passion or emotion. How greatly does the young man of today need the counsel of those who see life in its completeness and who may point the way by which each oncoming year from first to last may be brought to yield its fullest measure of satisfaction."

"If there is but a single certainty to which he may cling, it is that deep within all human beings there lies a power which, with time, inevitably makes for the better. The vector arrow of man has always moved upward. The certainty that it will continue to do so brings that attitude of mind vital to new strength, and abiding faith in an advancing human world."

## Ratio Structures

A NOVEL method for the construction of both temporary and permanent buildings which eliminates all need for rafters or trusses in the roof and for load-bearing walls is described in a report released today by the Office of Technical Services, Department of Commerce, Washington 25, D. C.

The report, written by Paul Lester Wiener for the Office of Production Research and Development of the War Production Board, describes a structural system developed by Mr. Wiener.

Called "Ratio Structures," the new system is based on the use of a self-strengthening arch, supported on a series of free standing posts. By its use, buildings are erected from the roof down, rather than from the ground up.

The technique was used in building a war-housing project at Sidney, N. Y., consisting of 160 houses and a community center.

The Ratio Structures system is effective whether metal, plywood, or composition board is used. Complete freedom in fenestration and other openings is afforded, since the outer wall panels bear no weight and are actually supported by the roof-post system. According to Mr. Wiener, great savings in materials and in construction time are made possible by his method.

An adaptation of the system, also designed by Mr. Wiener, replaces the arched roof with a standard box-girder flat roof. The air space inside the box-girder can be used for air circulation, for insulation, and even for the installation of plumbing pipes, electrical wiring, and heating and ventilating ducts.

The primary use for Ratio Structures is likely to be in the field of small public or industrial structures—hospitals, schools, warehouses, community buildings. However, the flat-roofed type particularly should have wide acceptability for low-cost housing.

Included in the report are extensive architectural and engineering drawings of all important details, as well as some floor plans for small houses, schools, recreational centers, and industrial buildings.

A limited number of copies of the report (PB-18529; 99 pages) is available free of charge. The text is in both English and French.

---

[1] "Practical Management Research," by A. R. Wiren and C. Heyel, McGraw-Hill Book Co. Inc., 1945.

[2] "New Strength for New Leadership," by Erwin H. Schell, Harper & Brothers, New York, N. Y., 1942.

# *An Immediate Measure to Strengthen the* PROFESSIONAL *and* ECONOMIC POSITION *of the* ENGINEERING PROFESSION

*This paper analyzes the reasons why many engineers have affiliated with labor unions and the advantages and disadvantages of such a course of action. It reviews the previous attempts and failures of the engineering societies to cope with the professional and economic problems of the engineering personnel. It refutes a widespread opinion that freedom of action has been destroyed by the National Labor Relations Act* (N.L.R.A.) *per se, and contends that the obstacles can be largely surmounted by adequate organization of the engineering profession.*

*An immediate course of action is proposed for establishing an effective means of improving the economic status of the engineer and at the same time strengthening rather than weakening the profession and the professional and social status of the engineer.*

*This paper does not purport to present an ideal or complete solution but rather combines the common elements from many proposals and presents a plan for immediate concerted action by the technical and professional societies and the entire engineering personnel.*

*To limit the length of the body of the paper, the reasoning underlying many of the statements and recommendations is discussed in two supplements. Supplement A discusses the pros and cons of unionization of engineers. Supplement B discusses the functioning of the engineering societies, the attitude of the* N.L.R.B., *and "***what engineers** *want."*

ASIDE from whether it is fundamentally good or bad, government sanction of collective bargaining for engineers has served a useful secondary purpose. It has demonstrated that the Founder Societies and other similar organizations are essentially *technical* societies whereas many engineers had regarded these institutions as *professional* societies designed to meet the organizational needs of the engineering profession.

These societies have assumed the responsibility for promoting the art and science of engineering and the development of standards and engineering practices, and have achieved excellent results. However, with a few notable exceptions, responsibility has not been assumed for providing an active program to promote the professional[1] and economic status[2] of the membership—the men who in a large measure determine the future of the art and science of engineering.

Particularly in the case of economic status, the work performed by most of the societies is regarded by the engineering personnel as intangible and of limited, if not questionable, value. Furthermore, the advice proffered by committee reports and articles published in the technical press has been so contradictory as to preclude the formulation of the "policy of the profession." Even if such a policy were established it would have little more than academic value, unless it were implemented by a live, dynamic organization dedicated to the objectives contained therein. It is extremely doubtful that such performance could be achieved in a profession which is divided into several hundred independent societies.

The engineer is well aware of this situation. He has contrasted it with the effectiveness of the unified effort of the labor unions. Now that the unions are redoubling their efforts to organize engineers, he is faced with an immediate and practical problem. Should he join a union? From the union he gets a definite answer—a statement of what has been accomplished for the many engineers who have already affiliated with unions, and a specific program of what it proposes to do for him. From the engineering societies he gets a variety of partial answers and usually no program of any kind.

The material presented herein is based on the experience of electrical and mechanical engineers in several large manufacturing concerns and may not be applicable, in its entirety, to the personnel engaged in other types of work. However, the authors believe that the recommendations embrace fundamental principles and are of such scope as to apply to practically all engineers.

## I PROS AND CONS OF UNIONIZATION OF ENGINEERS

Supplement A presents a discussion of this issue in terms of conditions of employment, privileges, prestige, relations with management, salary, and the relative advantages of independent engineers' unions. To summarize, we find that:

### ON THE POSITIVE SIDE

1 Experience has indicated that in a highly competitive society some form of "collective action" is necessary if any given group, professional or nonprofessional, is to maintain its relative position. To quote an old adage: "The squeaking

---

[1] Much credit is due the E.C.P.D. for its work on professional development. However, it is a committee project, almost unknown to the rank and file engineer, and has not imbued the professional attitude in the membership to any marked degree.

[2] The American Society of Civil Engineers has provided an extensive program to aid its members establish autonomous unions, and has met with some success. The American Chemical Society has carried out a program which has much in common with the recommendations given in this paper.

Prepared May, 1946, by the National Societies Committee for the General Electric Engineers Associations at Fort Wayne, Pittsfield, Lynn, and Schenectady. Valuable assistance was received from officers of the A.I.E.E., A.S.M.E., N.S.P.E., and scores of engineers, chemists, and metallurgists in both unionized and nonunion plants. The authors are also indebted to the American Association of Engineers for the factual information which it has published on this subject. C. W. Ransom, Pittsfield, Mass., is chairman of the Committee.

Contributed by the Committee on Education and Training for the Industries for presentation at the Fall Meeting, Boston, Mass., Sept. 30-Oct. 3, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

wheel gets the grease." The labor union's method of collective action, collective bargaining, has been established and has proved to be quite effective for some types of employees.

2 The unions are willing to accept the responsibility for improving the economic status of the engineering personnel.

3 Except in isolated cases, the engineers have not as yet developed a modus operandi on economic problems which even approximates the effectiveness of collective bargaining under the Wagner Act.

4 Collective bargaining provides a more effective means for the expression of employee opinion than now exists in many nonunionized plants.

### ON THE NEGATIVE SIDE

1 There is a fundamental difference between a profession and a trade. To take over the "tools" of the tradesman would, no doubt, inadvertently result in establishing nonsupervisory engineering work on the basis of a trade.

2 The engineers would be in the same position as other minority groups, such as toolmakers, who have been steadily losing ground and who have found no recourse.

3 Labor is making a concerted effort to revolutionize our economy. One goal appears to be the destruction of salary differentials based on relative contribution. Instead, each person is to contribute according to his ability and to receive according to his needs—a system which was tried in the U.S.S.R. and failed. Many professional, supervisory, and managerial people in industry are seriously concerned over the liquidation of the assets they have built up in the form of their ability to perform special services. To protect their own financial interests and preserve a reasonable sense of values the engineers have an obligation to counteract this trend, rather than contribute to it by giving support and financial aid to the labor unions.

4 Prestige, prerogatives, and privileges are personal acquisitions which would suffer irreparable loss under the rigidity of the present collective-bargaining practices.

5 Engineering in industry inherently constitutes the technical branch of management. Notwithstanding past failures in this regard, it now exists to a higher degree than most of us realize. It can be, and should be, developed to the fullest extent. Under collective bargaining that would be impossible, because by definition the engineers would be set apart from management.

6 In the case of an independent union, conditions of employment would have to be reviewed in terms of the policies established by the other unions in a given plant, or in effect, the other trades.

7 The solidarity which the engineering profession must have, if it is to acquire its rightful place in our economy, could not possibly be achieved. The profession would be divided into artificial supervisory and nonsupervisory groups, and further subdivided into impotent minority groups scattered throughout industry.

8 Unionization is entirely inconsistent with the goal of many engineers as reflected by Dr. Wickenden in the February, 1945, issue of *Electrical Engineering*.

> **Has the engineer done his job justly? Has he stood between capital and labor, between the employer and the employee, between the producer and the consumer, between public welfare and private gain, and served with reasonable impartiality the interests of them all? Not always, not perfectly, to be sure, but soundly and consistently, yes.**

The foregoing summary, and more particularly, the discussion in Supplement A, demonstrates that the general objectives of collective bargaining are in keeping with needs expressed by the engineering personnel. However, it is also demonstrated that the nature of engineering work, the history of our particular situation, practices, policies, interrelationships, and legal connotations are such that unionization of the engineers would seriously hinder rather than aid the over-all long-range objectives.

### DEFINITIONS

*Engineer.* The term "engineer" is used in the usual technical sense. It is not intended to extend the meaning beyond the reasonably workable definition given in the model registration law, as revised by the joint conference of the interested societies in August, 1945. However, much of the discussion applies to other scientific personnel, such as chemists, physicists, and metallurgists, whose work is of the same general level in terms of technical performance, judgment, and professional ethics. In other words, all members of the scientific profession as applied to technology and industry, but excluding such homogenous specialized branches as medicine and astronomy.

*Technician —Engineer's Assistant —Engineering Work.* These terms are sorely in need of definition. To provide such is beyond the scope of this paper. However, this problem cannot be avoided entirely in any realistic discussion of the subject. The profession has not provided and implemented adequate, consistent definitions throughout the engineering body. As a result the National Labor Relations Board (N.L.R.B.) has created definitions for the profession which cannot be ignored or changed in the immediate future. The Board has repeatedly refused to allow a group of employees to form a collective bargaining unit, or *waive* collective-bargaining rights on the basis of individual qualifications. The determination is based on the *function* of a *group*, and the type of skill—not the degree of skill.

*Professional Status.* This term is used to denote that status accorded to a technically educated, well-rounded, competent, scientific worker of wide vision who has a sense of social responsibility, by his associates, employer, nonprofessional people, and the public.

*Economic Status.* This term is used to express the level of material reward for engineering services relative to other people in the social structure, i.e., toolmakers salesmen, physicians, etc. It is related to professional status, as reflected through the engineer's ability to live on a plane consistent with professional dignity and afford educational and cultural advantages for his family and himself. It also has an influence on the type of people that are attracted into the profession; but the term is intended to signify only the relative financial position and resulting standard of living.

In the long run, an independent union probably has very little advantage over a national trade union, except for one important consideration. If, and when, a professional society is established, which effectively serves the economic needs of the engineers, the people in the independent unions have a much better chance of taking full advantage of that change.

Thus a solution must be developed which will accomplish for the engineers what the unions have accomplished for the nonprofessional people, without introducing the handicaps which a union would impose on the engineers and engineering performance.

## II PERFORMANCE OF ENGINEERING SOCIETIES—THE N.L.R.B.—NEEDS AND DESIRES OF ENGINEERING PERSONNEL

Supplement B discusses the four basic functions of a professional society—technical, professional, civic, and economic (remuneration); the attempts and failures of the engineering societies to meet these needs; the enigma of the collective bargaining issue; the attitude of the National Labor Relations Board (N.L.R.B.); the attitude of the engineers; and what the engineers want.

To summarize that discussion: We have in our midst the elements of a potential new profession ranking on a par with theology, law, and medicine. However, instead of developing as such, it is being fragmented and stratified into a multitude of relatively isolated groups.

The part played by the N.L.R.B. is particularly significant. Entering the picture afresh, in 1935, the Board found no unified policy in the engineering profession and no effective program for professional development or economic improvement of the engineering personnel. Conditions were such that the Board had no choice other than to deal with each group, involved in a "representation" case as an isolated unit. In the conduct of its work the Board has inadvertently established definitions for the profession which seriously complicate the situation. The engineer is caught between the deficiencies in the organization of his profession and the administration of labor laws designed primarily for the rank and file worker.

However, as illustrated in Supplement B, there is substantial reason to believe that, despite the Wagner Act, engineers would not have been forced into collective bargaining units against their will if they had had a professional society adequately performing the functions outlined therein.

The individual engineer may want anything ranging from the aid of a militant labor leader to no organization of any kind, depending, in part, on his particular environment. But, basically and collectively, the desires of the engineers are essentially as follows:

The typical engineer wants to work under a system in which he can develop his abilities to a maximum extent, utilize them to the best advantage of society, his employer, and himself, and be assured of a financial return commensurate with his performance. He wants to be a living part of a dynamic professional organization dedicated to these objectives. He wants to be free of fear of losing his prestige, social position, or economic position; free of the fear of being made subservient to trade unionism; and mentally and emotionally free to devote himself wholeheartedly to the inspiring task of greater engineering achievement. He wants the comforting assurance that he has acted wisely in choosing the engineering profession and in selecting his particular employer.

Practically no one will take exception to these objectives. But, like sanctification, general improvement is slow under the normal process of evolution. Furthermore, such evolution is not to be expected in this case. Unless engineering is defined, delineated, and established as a profession—and recognized as such by the N.L.R.B.—in the near future, the many stratified labor groups will establish it as a trade. Under our national system of increasing regimentation, it must become one or the other.

This entire situation is charged with intense anxiety and dissension. It is practically devoid of leadership or organized effort of any kind, except within isolated groups. That such a condition could develop within the engineering profession—known for its organizing ability—is one of the paradoxes of our times.

### DEVELOPMENT OF A SOLUTION

Many proposed reorganization plans have been published recently, in the technical press,[3] both for the purpose of discussion and the recommendation of long-range solutions. There is no question but what such considerations are highly desirable, but we believe there is an imminent danger that the professional societies may find that they have been "fiddling while Rome burns." By the time general agreement is reached as to the best over-all solution such a large percentage of the engineers may have become absorbed by various labor unions as to render any solution impossible. Likewise, the policy of the N.L.R.B. may become influenced by the heterogeneous labor unions to such an extent as to block any constructive move by the profession.[4] The much discussed modification of the Wagner Act will be of little value if in the meantime the professional people lose their identity in the mass labor movement.

The solution, therefore, must be divided into two parts:

1 A long-range project to integrate the profession so as to fulfill effectively the four basic functions discussed in Supplement B.

2 An immediate, full-scale attack on the professional and economic problems to bring these functions under control as quickly as practicable.

### THE LONG-RANGE PROJECT

It is suggested that the excellent work being done by such groups as the Subcommittee on Organization of the Engineering Profession (A.I.E.E.) be co-ordinated with similar work in the other technical societies, the National Society of Professional Engineers, and the American Association of Engineers, with the objective of realigning, as soon as is practicable, all such organizations—according to function—in a single professional society.

### IMMEDIATE ACTION ON PROFESSIONAL AND ECONOMIC STATUS

*Objective.* To establish the solidarity of the engineering profession on those problems which are common to all engineers and which are particularly critical at this time. To provide a concerted and continuous program to raise the level of performance and increase both the tangible and intangible reward for engineering services. To demonstrate to the N.L.R.B. that professional status and economic status are being integrated and that the financial interests of the engineers are being more adequately handled than would be possible under trade-union policies. Lastly, to establish this program on a basis which is inherently consistent with the normal functions of a single national professional society so that it will, more or less automatically, fit in with whatever plan may be evolved by the foregoing long-range project.

*Legal Considerations.* The N.L.R.B. has made no attempt to extend the definition of collective bargaining beyond that given in Section 2, Par. 5, of the N.L.R.A. which specifically limits collective bargaining to "—dealing with employers—." Thus, any action which does not constitute ***dealing*** with a ***specific*** employer, for a *specific* individual or group, is not bargaining in the legal sense.

The fact that objective measures may be more effective than collective bargaining does not impair the legal standing of a nonunion group. Thus there is no legal reason why a professional society should not provide a clear-cut program to improve the economic status of the engineering personnel. (This is discussed in detail in Supplement B.)

---

[3] Two of the most recent papers are: "The Report of the Subcommittee on Organization of the Engineering Profession," *Electrical Engineering*, April, 1946, and "A National Spokesman for Engineering," published by various societies and included in the April, 1946, issue of MECHANICAL ENGINEERING.

[4] In April, 1946, the National Federation of Salaried Unions sent a letter to the N.L.R.B. which stated in part: "We object to the practice of the N.L.R.B. of separating professional and technical employees from office and clerical employees in representation cases."

In the interval required to establish full coverage on a professional basis, it may be necessary for many groups of engineers to choose between an independent union and representation by a heterogeneous group. In such instances the entire profession is greatly indebted to the American Society of Civil Engineers for appropriating funds and supplying personnel to aid their members form such unions. Despite their limited success and the forced compromises in membership requirements, that work has helped civil engineers avoid handicapping situations and has set precedents for other engineering groups.

Engineers have also been materially aided by the manual on collective bargaining published by the American Association of Engineers (A.A.E.),[5] entitled "The Technologists' Stake in the Wagner Act." It is most valuable to any group of engineers who wish to form an independent union or to waive collective-bargaining rights. This excellent book, and the supplement now under preparation, covers the subject so well that the other societies can safely entrust that function to the A.A.E. and devote their efforts to a basic solution of the problem.

To give perspective to the proposed course of action it is desirable to consider briefly two possible alternatives and the reasons why these are not recommended by the committee.

*The N.S.P.E.—To Perform Professional and Economic Functions.* Anticipating the situation in which we find ourselves today, forward-looking engineers founded the State Societies of Professional Engineers and later the National Society of Professional Engineers (N.S.P.E.). This presumably was not considered to be an ideal solution but rather a workable expedient to achieve a balanced program through co-operation between the technical societies and the N.S.P.E. Up to the present time it has not been very successful.

In the June, 1945, issue of *Electrical Engineering,* J. F. Fairman suggested that the rank and file engineers force the issue by joining the N.S.P.E. and making it the official professional organization of the engineering personnel in the country. In January, 1946, William F. Ryan, president of the Massachussetts State Society of Professional Engineers, presented an excellent paper sponsoring that proposal.

They point out several significant advantages. The N.S.P.E. is prepared to represent all engineers irrespective of the branch of engineering. It is not financed, directly or indirectly, by industry. It is composed solely of people whose engineering qualifications are established by law. Lastly, it has expressed a willingness to assume responsibility for improving the professional and economic status of the engineering personnel.

This possibility has been discussed with a number of groups of engineers in industry. These people are sympathetic to the idea and appreciative of what the N.S.P.E. has done, but are of the opinion that it could not be accomplished in the near future. They voice six specific objections:

1 There is a reluctance to belonging to two professional societies.

2 If successful it might result in the migration of engineers from the technical societies and provide an unbalance in the opposite direction.

3 The engineers in industry still have a strong aversion to registration, a prerequisite to membership in the N.S.P.E.

4 In some states the laws are such as to make registration difficult and may discourage prompt action.

5 The negative attitude of many of the engineering societies toward the N.S.P.E. has caused some of the engineers to look upon it with disfavor. Many others have scarcely heard of the organization.

6 A firmly established policy of the N.L.R.B. has made the technicians a part of the engineering body, at least for the time being. These people are not eligible for any form of membership in the N.S.P.E. However, this "charge" of the engineering profession must be handled with extreme discretion while the present "tangle" is being "unraveled."

*Federation of the Major Societies.* The functions which are most critically in need of attention, the professional status and economic status of the personnel, are primarily personal matters. The success of any collective program, therefore, will be dependent on the amount of individual participation. But a federation of societies provides a minimum opportunity for such participation by the individual members. It was this type of remote control that was responsile, in part, for the limited success of the various joint society activities discussed in Supplement B. A repetition of this serious weakness should be avoided.

### RECOMMENDATIONS FOR A JOINT PROFESSIONAL AND ECONOMIC DIVISION[6]

1 It is recommended that one of the founder societies, or preferably all of them in unison, take the initiative in setting up an Engineers' Professional and Economic Division, to operate on a professional nonunion basis—as a semiautonomous committee or board; and,

(*a*) That all other engineering societies be invited to participate, particularly the N.S.P.E. and the A.A.E.

(*b*) That this Division be operated by nonsupervisory engineers (as determined by the present, though artificial, distinctions according to the labor laws).

(*c*) That this Division be made responsible to the membership of the Division, not the governing bodies of the sponsoring societies.

(*d*) That the initial committee, or board, in charge of this Division be appointed by the sponsors, and that it be elected by ballot by the membership at the end of an initial period of, say, one year.

(*e*) That the first year's operation be financed by a substantial grant from each of the sponsoring founder societies and corresponding amounts from the smaller societies. During this period all members of the sponsoring societies would be considered as members of this Division.

(*f*) That after the first year the Division membership consist of those engineers who choose to contribute an amount assessed to cover the operating costs for the coming year.[7]

(*g*) That qualified individuals not holding membership in one of the sponsoring societies be given the opportunity of becoming members of this Division.

(*h*) That the membetship of the Division be classified as: (1) professional engineers, on the basis of registration or a committee's interpretation of qualifications under the proposed model law, or a revision thereof; (2) engineer-in-training, as determined on a similar basis; (3) other engineering personnel as delineated by the N.L.R.B. in representation cases presented by the American Society of Civil Engineers.

(*i*) That the Division aid local groups in setting up chapters or committees, in response to interest expressed by member engineers, the chapters to be an inherent part of the Division. (These local groups to take whatever form provides the greatest community of interest. In many cases this would be a given industrial plant.[8] An informal tie between groups within a given company should be encouraged.) Many professional problems are inextricably tied up with industrial relations. These vary and should be expected to vary with many factors. The problem of developing the profession must be approached with an integrated program on both a local and national level.

---

[5] American Association of Engineers, 8 South Michigan Avenue, Chicago 3, Ill.

[6] The authors make no claim of originality. In fact, the proposals contain ideas obtained from the officers of several societies and other individuals too numerous to mention.

[7] It might be advisable to limit the assessment to nonsupervisory engineers, but that does not appear to be necessary.

(*j*) That these several local chapters, in an area covered by an Engineers' Council, be considered as a possible functional group contributing to the activities of the Council.

(*k*) That consideration be given to the early formation of state groups.

(*l*) That great care be taken to pave the way for close harmony and co-operation between this Division, the National Society of Professional Engineers, and the American Association of Engineers and, if practicable, the eventual coalition of these three groups.

(*m*) That the development of professional standards through registration and the enactment of registration laws adapted to the benefit of engineers and engineering work, as well as the protection of the public, be fostered.

(*n*) That the details of organization and operations of this Division be modified from time to time, by the Division, to permit it to fit smoothly into the ultimate reorganization of the profession into a single national society.

2 The purpose and aims should embrace the objectives outlined previously and discussed in the section "What Engineers Want," Supplement B.

3 A program should be set up to achieve these aims and objectives as soon as a reasonable solidarity of opinion has been established throughout the membership.

4 A tentative policy and philosophy should be prepared and discussed with individual engineers in all types of work situations and on all levels of the professional hierarchy, union members and nonmembers, small groups and large groups throughout the entire country, and revised and reshaped again and again to embody every good and compatible idea, and make the program of the Division the "engineers" program. This will require at least two men full time to stump the country in response to requests from members, at section meetings, etc.

5 To reach a maximum number of people at reasonable cost a monthly publication should be sent to all members of the sponsoring societies (only members of this Division after the first year). It should contain a section covering the foregoing exchange of ideas; a section on professional development utilizing the E.C.P.D. and outstanding leaders of professional thought; an economic section utilizing all information available from the various society committees, the Bureau of Labor, employee groups, employers, and other sources; and a section devoted to an analysis of collective-bargaining representation cases involving engineers. The best talent in the profession should be utilized on this publication.

6 Keep the N.L.R.B. informed of this work but expect no change in the Board's attitude towards the profession in less than two years.

7 At the end of the first year, concurrent with the election, issue a progress report and statement of the future outlook, and word the ballot so as to take the form of a vote of confidence, or rejection, by the membership.

### CONCLUSIONS

Engineering (including chemistry, physics, metallurgy, etc.) by virtue of its fund of specialized knowledge, contribution to society, and the character of its members, is potentially a learned profession—a fourth profession, along with theology, law, and medicine.

With governmental control entering every field of endeavor, no group can exist as a nondescript. Engineering must become established either as a profession or a trade.

Due to the past reliance on societies which are fully effective only in the technical field and the absence of organization as a profession, engineering has been migrating toward permanent status as a trade—as witnessed by the stratification into artificial supervisory and nonsupervisory groups.

This trend can be reversed only by forthright measures to fulfill all of the functions of a professional society—on technical, civic, professional, and economic problems.

Such a project, at this late date, is a gamble and is quite expensive. But it is a gamble that the engineering body cannot afford to reject, regardless of the cost. The recommendations given in this paper, or an equally virile modification thereof, should be effected immediately.

## Supplement A: The Pros and Cons of Unionization of Engineers

It is recognized that the unions have achieved substantial benefits for some classes of employees. It would be foolish to argue that engineers should pursue some other course if a union will adequately satisfy their needs. Let us analyze the most commonly raised issues—engineers' condition of employment, privileges, prestige, relations with management, and salary—in terms of collective bargaining; and the question of independent engineers' unions.

### CONDITIONS OF EMPLOYMENT

The rapidly disappearing differences in conditions of employment between the average worker and the engineer have been viewed with alarm by many engineers. However, it should be remembered that this is due, in part, to the engineers' own policy of providing more goods for more people, thereby effectively raising the standards for all people.

On the other hand, newly created bargaining units, embracing the engineering personnel, have skillfully attacked the backlog of undesirable industrial-relations practices and, in many cases, have achieved substantial benefits for the engineers. This has given rise to the hope that collective bargaining would counteract the foregoing relative loss suffered by the professional workers. Close observation has indicated that this is not the case. Union leadership must respond to the interest of the majority. Consequently, after the initial "up surge" is past, union control of the engineering group tends to accelerate the "leveling off."

This would not be the intention of an independent engineers' union except, possibly, within the engineering group. However, a management could not set up separate policies for dealing with two unions without introducing the question of favoritism and creating an extremely bad industrial-relations situation. Thus in the case of "conditions of employment," the rigidity of collective-bargaining practices would tend to bring about even closer alignment between the professional and nonprofessional people, thereby defeating the purpose it set out to achieve.

### PRIVILEGES

Under our system of free enterprise, privileges are a byproduct of superior performance. Engineering work is inherently creative. Despite the changes on the labor front, engineering continues to present essentially the same opportunities for the individual to exercise initiative and judgment and to make contributions which justify "privileges" differentiating him from the rank and file.

---

[8] At least four such groups are now in existence. The framework for tying these in with such a proposed Division is now being established.

To illustrate, consider the case of an unusually successful design engineer. When developmental tests are being made on a new design, he may be found in the apparatus testing department night after night, at midnight, and then again at 8 a.m. to start the day shift on a new approach. Of course, that is not necessary, but it is that individual's way of giving birth to a new idea; and his record happens to be outstanding. When he brings a job to successful completion and relaxes, he is tired. Is it not reasonable that he should take a rest? Such a special consideration constitutes a "privilege" applicable to the circumstances.

The exercise of such initiative requires a degree of freedom in one's relationship with management which would be very difficult to maintain under collective bargaining with the usual rigid job classifications and specific rules embodied in a union contract. Most contracts, written to be used as bargaining instruments, tie down employer-employee relationships in minute detail. This might make the granting of well-earned privileges so difficult as to discourage the practice completely. Hence the opportunity for acquiring privileges would be destroyed and, with it, a part of the incentive inherent in creative work.

### PRESTIGE

We are confronted with the paradox wherein the prestige of engineering is extremely high and the prestige of the engineer is relatively low. Engineering is rated especially high at this time because the public is well aware of the fact that it was a determining factor in shortening the war. The engineer is rated low because, unlike his handiwork, he has not stood out over and above his environment.

As the result of years of systematic development and publicity, the public has been made to think of the American Medical Association and the Bar Association as powerful influences affecting the destiny of our country. This undoubtedly contributes much to the esteem rendered the members of those professions. On the other hand, if John Q. Public has ever heard of the A.S.M.E. or the A.I.E.E. he thinks of them, perhaps, as fraternities or organizations which publish a journal.

Since we live in a dynamic society, any group which does not forge ahead automatically suffers a relative loss. In addition, the existing prestige of the engineers has received a serious blow in each instance where they have set themselves apart from management to form a union under the terms of the Wagner Act. The nonprofessonal workers had loosely considered the engineers as a profession and, in effect, a branch of management, and were surprised and amused to learn that the engineers, themselves, did not recognize such a status.

Prestige has definitely been lost, but it has not been taken away from the engineers by the government, management, or any other agency. Neither can it be restored by anyone outside of the profession. Prestige, like a reputation, cannot be legislated or written into a contract. It must be won and constantly maintained. It seems, therefore, that the engineers' only solution lies in the professional development of each member integrated into a strong, recognized national professional society. Certainly, prestige cannot be enhanced through the medium of a labor union.

### RELATIONS WITH MANAGEMENT

Thirty to forty years ago companies were small and the engineers and management worked hand in hand. As the organizations expanded, management centralized, engineering specialized, and the two began to grow apart. Management did a poor job of maintaining communications. The engineers did a poor job of crystallizing engineering opinion on general problems of mutual interest. The influence of the opinions of engineers on company policies began to deteriorate.

In 1935 the Wagner Act caught the development of the engineering profession in the embryonic stage. There were no clearly distinguishing features between the engineers and employees as a whole. For many years the engineers found no effective means of restoring group interchange of ideas with management on any subject relating to conditions of employment. This resulted in driving a wedge further alienating the two groups, irrespective of their desires in the matter.

A union would provide a tailor-made device for restoring this interchange and presenting the engineers' case and point of view before management. To this end it would serve a real need. But it would have to be done on a representative basis with a further reduction in the freedom of the individual.

That the professional group should have developed no mode of operation peculiar to its needs (except in isolated cases) is a sad commentary on the engineering profession. Looking at the entire problem from the vantage point of our enlightened hindsight, it is easy to see that the fault rests with both the management and the engineers. Dividing the two groups into separate camps under a formal union setup would, no doubt, aid in treating the symptoms (a grievance is usually a symptom of something not stated by the aggrieved); but would also contribute still further to the cause of the difficulty.

We believe that one important step in the solution consists of making the engineers a part of management rather than apart from management. This, of course, would be impossible if the engineers were members of a labor union.

### SALARY

The salaries of individuals at the top have long been a matter of public record. The earnings of the low-income group are well known. But in the middle group, including most engineers, salary has been on the list of taboo subjects. Until recently, engineers as a group preferred to enshroud their income in dark secrecy. To wit, the extreme reluctance to fill out anonymous salary questionnaires.

It is logical that this secrecy on the part of the individuals should have carried over into the policy of the employers. To reflect the sentiments of the employees is a recognized obligation of the management.

In addition, years ago some managements considered secrecy in regard to rates of pay to be useful as a competitive tool—much the same as a secret manufacturing process. However, changes in industrial-wage practices in this country over the past twenty years have essentially eliminated this condition.

An even more pronounced change has occurred in the attitude of the engineering personnel. The views of the recent college graduate on the salary question are quite different from those entertained during the early part of the century. There has developed a deep-seated and almost universal fear that the pressure groups may deprive the engineering employees of their equitable share of the total earnings and, perhaps, that this is already the case. As a result of these several changes, it is now generally recognized that an engineer should clearly understand the salary structure of his organization, or of the various concerns with whom he is considering employment. Likewise, the anticipated lifetime salary, not merely the starting rate, is accepted as one of the many factors involved in considering a position.

Hence it is now possible to take a frank, logical approach to the salary question.

As one possible solution, let us examine a national labor union's handling of the salary problem for a group of factory employees, including skilled workmen. In this instance, a thorough job-evaluation system had been in force for many years prior to the entry of the union. Merit rating was an integral part of the plan. There was a "spread" allowed for differences in performance. In a relatively short time the system was modified to give a fixed rate for each job. Merit was still recognized, to a degree, through a provision for stopping the automatic increases at a point indicated by the performance and by allowing preferred rates in exceptional cases. However, that was only temporary. Last year the union contract abolished all differentials for codes under $1 per hour and stated that fixed automatic increases, up to top rate, shall be paid irrespective of performance.

Inch by inch the condition has been established whereby the best shall be paid no more than the poorest.

The committee has also studied the salary data from a group of engineers (in another company) affiliated with the same union. In that case there is still a wide spread in the stated salary range for each code. However, the structure is such that essentially all of the people are at the top of their code ranges. Thus, although recognition of merit still exists on paper, it has been abolished in practice.

It is not the intention of this paper to cast a reflection on any individual or organization. It may be that under present conditions representative bargaining, the so-called collective bargaining, must function in this manner.

In those cases which have been observed firsthand, the below-average people are very well satisfied. Whereas, among the more competent employees the loss in initiative and impaired morale has been quite pronounced.

A significant side light is also revealed in the constitution of the Federation of Architects, Engineers, Chemists, and Technicians (FAECT). It states as its objective "—securing for all technical employees the standard of living—justly entitled them—." But note Article X, Section 8, "No paid official shall receive greater remuneration than he would if he were employed in the technical field under FAECT wage standards, the exact amount to be fixed by GEB but no salary shall exceed $3600 per annum."

That evaluation of an engineer's worth, compared with the objections being raised by engineers over alleged top salaries of only $5000 to $6000 for competent nonsupervisory engineers, indicates the stifling influence that would be imposed by union control.

Viewed in terms of past performance, it is clear that the policies and practices of the trade unions are quite inadequate for coping with the salary problem of a high-caliber engineering personnel. Union control would inadvertently result in a "leveling" both within the engineering group and between the professional and nonprofessional people. Unlike the present situation, the engineer would have practically no opportunity to do something about it.

### INDEPENDENT ENGINEERS' UNIONS

The creation of independent unions would eliminate, or tend to eliminate, uncongenial representatives and, perhaps, partially offset some of the handicapping features previously discussed. Furthermore, in a company made up largely of engineers some of the objections do not apply. However, there are three serious limitations:

1 Most employers of engineers have labor groups in the trade unions. They could not be expected to differentiate between company policies applied to two certified bargaining agencies. In the aggregate the engineers would be a small minority and would, no doubt, have their policies determined by the tradesmen.

2 Experience has shown that independent units are handicapped by lack of power and lack of funds and are particularly subject to jurisdictional disputes. A federation of all independent engineers' unions would still be only a "drop in the bucket" as compared with the trade unions.

3 Current trends indicate that all small unions will ultimately be absorbed, or at least controlled, by one or two major national unions.

On the other hand, the practice of creating independent engineers' unions should not be rejected in toto at this time. There are instances where it may be a highly desirable temporary expedient, for the following reasons.

As discussed elsewhere in this paper, there are most encouraging indications that a nation-wide professional organization will be established in the near future for handling the professional and economic problems of the engineer on a basis which is quite superior to that employed by the unions. It will take some time to create such an organization and make it an established, effective vehicle. It may take still longer to demonstrate its solidarity and effectiveness to the National Labor Relations Board. If, in the meantime, engineers become committed to the trade unions and are part of heterogeneous groups, they will find their future course dictated by those organizations. Whereas the independent union groups will be free to choose for themselves and can take advantage of whatever action they believe will best serve their economic and professional interests.

To maintain this degree of freedom it is essential that groups faced with the imminent inclusion in a heterogeneous union take immediate action to form independent unions. It is not proposed that engineers form independent unions in "bad faith" but rather that they pave the way for the most satisfactory long-range goal.

## Supplement B: Inadequacy of the Societies—Attitude of N.L.R.B.—What Engineers Want

There are those in the profession who accuse the younger engineers of allowing self-interest to take precedent over the development of a professional outlook and attitude. Based on surface evidence this criticism is just. However, the circumstances are such as to present a wide margin for error. Hence, before attempting to set up a basis for the solution it is necessary to explore beneath the surface.

### FUNCTIONS OF A PROFESSIONAL SOCIETY

The basic functions of any professional society may be summarized as follows:

1 The exchange of technical information to advance the art and establish standards.

2 The establishment of qualifications and other measures to elevate the caliber, competence, and standing of the members.

3 The application of the heritage of the profession to the common good of society.

4 The realization of a reasonable financial return for the services rendered by the profession.

It is essential that these functions be integrated in the thinking and performance of each professional man, individually and collectively, through the medium of his society. To disassociate any one function from the others weakens the whole. This is particularly true of the last three, all of which are inextricably tied up with the individual—in this case, the engineer.

### FUNCTIONING OF THE TECHNICAL SOCIETIES

A review of the constitutions of the founder societies indicates that the founders did not anticipate the phenomenal growth of their scientific work and the resulting changes in our economy. Consequently, instead of organizing a professional society to fufill these four functions, they provided several vehicles for the exchange of technical information (function 1 above). When it became apparent that a potential major profession was being created, between 1910 and 1920, the society officers recognized this deficiency.

If the several societies had been organized as divisions of a single national organization, it would have been comparatively simple to amend the constitution and add new divisions covering the other three functions. Lacking that type of a foundation, the major societies decided to take joint action on problems common to all engineers, through intertying committees. In 1920 the Federation of American Engineering Societies was formed. It operated under the direction of the American Engineering Council. In 1924 the name was changed to the American Engineering Council. This was followed by the Engineers' Council for Professional Development in 1932, and the Joint Conference Committee in 1941—the name of which was changed to the Engineers Joint Council in 1945.

It is significant to note that the rank-and-file engineer could join none of these groups and that, despite the excellent work done, the average engineer has practically no concept of the objectives or accomplishments. This is not surprising because people seldom become seriously interested in any activity unless they can identify themselves with it. It explains, in part, the engineers' complaint that the technical societies are paternalistic organizations.

Furthermore, the people who control the societies are about one generation removed from a substantial number of the engineers. Almost without exception the members of the governing body are personally exempt from vital issues such as collective bargaining. In addition, they are largely people in managerial positions who, with a few exceptions, have been restrained, since 1935, from frank discussions with their own groups. Consequently, mutual understanding is conspicuously absent.

There is also a prevalent opinion that, since the people who control the technical societies are mostly from managerial positions, the society policies are designed to favor employers at the expense of the engineering personnel. Some engineers contend that "the benefits from the technical societies seem to be entirely to the large companies and do not further the profession."

These influences have tended to create an isolated superstructure which is, in reality, almost detached from the engineering body. There are notable examples of individuals, both at the top and the bottom, who have broken through these barriers. But on the whole a good rapport has not been maintained between the administrators of the societies and the rank and file engineer.

Still worse are the dissensions and contradictions among competent engineers in the higher eschelons of the profession. Some have clearly demonstrated the incompatibility between present-day unionism and a profession and have advised the engineers accordingly. Others are subtly, but effectively, advocating the creation of independent engineers' unions. These, apparently, are not being advocated as a means to an end—a stopgap to give the profession time to correct past deficiencies—but rather as an end in itself. That such sharp differences of opinion should be expressed publicly, ten years after the enactment of the National Labor Relations Act, is most unfortunate.

The wide discrepancies in the policies of the various technical societies have given rise to the question, "Where is the policy of engineering profession?" Of course, the profession as such can have no policy so long as it is divided into some 90 separate societies (several hundred, if regional groups are included).

To correct these conditions groups of professionally minded engineers organized the various State Societies of Professional Engineers and in 1934 combined them into the National Society of Professional Engineers. This provided an opportunity for the various engineering societies to turn over all functions, except the technical, to the N.S.P.E. However, the societies did not respond to this opportunity. Thus it has resulted in competition, a paralleling of functions, and added confusion.

This confusion has been reflected in various ways. Perhaps the most detrimental are the gross misinterpretations of the National Labor Relations Act (N.L.R.A.). Many engineers have been given the impression that any form of effective collective action to improve economic status constitutes collective bargaining as defined by the law. As a result, so much emphasis has been placed on the reasons why the technical societies cannot act as bargaining agencies[9] that the real issue has been lost in the shuffle. Most of the engineers who have joined unions did not do so because they wanted collective bargaining, but rather because they could not interest the societies in performing the normal professional function of advancing the economic status of the engineering personnel. In so far as the direct issue is concerned, the N.L.R.A. is merely a red herring.

In recent years this has probably done more than any other one thing to alienate the interest of the engineers in the technical societies.

In developing a program for the future, consideration must be given to the fact that past precedents have established a cleavage between supervisory and nonsupervisory engineers; and that the N.L.R.B. can be expected to look with suspicion upon any move made by the societies. These factors were taken into account in drawing up the recommendations given in the body of this paper. For example, it is one of the reasons for recommending that the proposed Professional and Economic Division be operated by "nonsupervisory" engineers, and for making them responsible to the membership rather than to the board of directors of the sponsoring societies.

The nebulous state of the organization of the engineering profession as a whole and the failure of the component societies either to confine themselves to the technical advancement of the art or assume the full responsibility of a professional society has produced very unfavorable results. It is, no doubt, largely responsible for the lack of solidarity of opinion among engineers, the stratification of the profession by the unionization of engineers, and fragmentation through the creation of still more technical societies.

As a result, in so far as the rank and file engineer is concerned, there is no effective liaison between the engineering groups, the engineer and the public, the employer, or the government.

However, there is a bright side. Competent men on all levels in the technical societies are now carefully and boldly reevaluating the situation. They are progressive men of vision who do not discount new proposals with a recitation of past failures or revere the status quo. They are soliciting ideas and criticisms from the rank-and-file engineer. An entirely new pattern is being evolved. The sincerity and zeal with which this is being done warrants the active support of all engineers.

---

[9] The American Society of Civil Engineers is a notable exception. Its collective-bargaining activities are summarized in the March, 1946, issue of the *Professional Engineer*, published by the American Association of Engineers, 8 South Michigan Ave., Chicago, Ill.

### ATTITUDE OF THE N.L.R.B.

The record of the National Labor Relations Board (N.L.R.B.) is quite different from that of the engineering societies. It has taken a factual over-all approach and has methodically built a clearly defined, although constantly changing, policy. Contrary to popular opinion, the board has not indicated a desire to proselyte or foist unionism upon the engineering profession. However, it is charged with the responsibility of assisting employees in improving their economic status through collective bargaining. Hence it has taken cognizance of the many published articles decrying the economic status of the engineer.

In each case of a "question concerning representation," it has conducted a realistic review of the history of the group in question. It has discovered a wide diversity of opinion from group to group. If the Board has been partial to combining engineers in unions dominated by nonprofessional people, the engineering profession is at least equally at fault for not having demonstrated a clear-cut distinction between the interests and objectives of professional and nonprofessional employees and assuring the Board that the economic status of the engineering group is being satisfactorily handled on a professional basis.

The Board has established the following policy: When it is clear that the economic interests of the employees will not best be served by including the engineers in a trade union with other employees, the engineers are to be given the opportunity to select the bargaining agency seeking to represent them, or to reject collective bargaining. This should have constituted adequate protection.

However, the previous disdainful attitude of the professional societies toward handling the economic status of the engineer on an objective professional basis and the resulting eagerness with which many engineers have turned to collective bargaining have created a situation which practically precludes any assurance that the Board will give engineering groups an opportunity to waive collective-bargaining rights, or even to form independent unions, unless and until: (1) A law is enacted making "Globe" elections mandatory, that is, requiring that the engineers be given the opportunity to vote, as a separate group, for or against a union which is seeking to include them in a heterogeneous bargaining unit; or (2) positive evidence is given of a basic change in the engineers' professional organizations. In the meantime, it is to be expected the engineers will continue to be forced into unions against their will and be represented by people whose policies are entirely foreign to their desires and best interests.

### ATTITUDE OF THE ENGINEERS

A large percentage of the engineers are frankly worried as to where they will "come out" in the present industrial revolution.

Increasing pressure is being brought to bear by the trade unions. Some engineers are being "sold" by the labor organizers. Some are being included in collective-bargaining units against their will. Others are creating independent unions, primarily to avoid being placed under the domination of heterogeneous unions and the control of the national labor leaders.

One element refuses to consider the question of unions until a labor organization has been created by their fellow workers, either professional or nonprofessional. At that point it is usually too late to do anything about it. Some of these groups are struggling in an almost futile attempt to extricate themselves from an uncongenial and handicapping situation.

Despite these variations, the voluminous expression of common opinions, proffered by the men on the firing line, provides reasonably accurate information on what the average engineer does and does not want.

*He does want (on matters pertaining to economic status):*

1 An equitable compensation relative to the nonprofessional employees.

2 A wide spread in engineering salaries. (If a man succeeds in sustaining twice as great a contribution as the average he wants to be remunerated accordingly, that is, within the normal limits of error in determining his value.)

3 To know at all times how engineering salaries compare with those in the other professions and with the nonprofessional employees. The elimination of uncertainties through use of facts by which disconcerting rumors can be proved or disproved.

4 A professional organization which will take such *objective* measures as:

(*a*) Publishing comparisons between the salaries of engineers and all other significant groups.

(*b*) Publishing comparisons between the various general types of engineering work—communications, utilities, manufacturing, etc.

(*c*) Publishing comparisons between the salaries paid by each of the large companies.

(*d*) Presenting the data in (*b*) and (*c*), above, on the basis of the median and various percentiles in such a way as to demonstrate the "spread" to place a premium on performance and encourage initiative (thus giving an advantage to progressive employers who develop their engineers and provide an opportunity for superior performance).

(*e*) Present these data to student members in the colleges.

(*f*) An employment service in which the salaries paid by various employers is correlated with all other factors relating to employment.

5 A program for continuing education after leaving school to develop the value of the individual and justify a higher level of remuneration.

6 The foregoing activities (function No. 4 in the outline at the beginning of this discussion) integrated with the other three functions—so as to give a maximum freedom of action and opportunity to contribute to the common good of the profession and to society; and to enhance the dignity of his position through recognition of the individual's achievements.

*He does not want:*

1 A representative to deal with his employer concerning his salary.

1 A paternalistic system by which someone handles his grievances.

3 Salary rates negotiated by an organization responsible to the majority, which is, inadvertently, under compulsion to act in the interest of the median group, thus pulling in the ends of the distribution curve and restricting the reward for merit.

The above tabulation of what the engineer does not want is collective bargaining as established by law. The tabulation of what the engineer does want *does not constitute collective bargaining* and is compatible with other major interests on professional, civic and technical matters. Any attempt to achieve these ends through collective bargaining would create, in most cases, close interrelationships with union groups whose philosophy is diametrically opposite to some of the most significant issues. Thus these problems must be handled on a professional, nonunion basis.

# FOREIGN TRADE, FOREIGN INVESTMENT, *and* AMERICAN PROSPERITY[1]

By LIONEL W. McKENZIE, JR.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAN America maintain its high wartime levels of income and employment by diverting its war production to production for export? Recently Congress provided for American participation in the International Monetary Fund and the International Bank for Reconstruction and Development, which are intended to facilitate international trade and investment. In approving these projects, Congress clearly anticipated that they would have a favorable effect on American prosperity. To what degree is such an expectation justifiable? These are questions which were considered, prior to action by Congress, by Dr. Calvin B. Hoover in a publication of the Committee for Economic Development, an organization of business men, and by the Colmer Committee of the House of Representatives.[2] Their conclusions are a warning against excessive dependence on foreign exports for production and employment, and at the same time a persuasive appreciation of the important contribution our exports can make both to our own and to the world's present and future income.

There are two quite different ways of stimulating our exports, one by a general reduction of the barriers to trade by all countries together, thus expanding both our imports and exports, the other by facilitating foreign lending and thus providing foreigners with the necessary dollars to increase their purchases here. The first method is the plan of the Fund, the second that of the Bank. Both methods are treated by our authors and we will review them in turn.

The present obstructions to foreign trade existing the world over were erected in large part during the depression of the thirties. As productive activity declined throughout the world, all nations simultaneously suffered declines in exports. They soon began attempting to forestall further contraction of their production for export by special measures to encourage foreign demand, often through currency depreciation. At the same time, in order to secure a larger share of the home market, imports were restricted by tariffs or quotas. Obviously, since one nation's exports are other nations' imports, to the extent that one nation succeeded in this program, the others necessarily failed. The process has been succinctly termed "exporting depression." Indeed, after the policy of restriction has made its rounds, the net result is merely reduced international trade with loss of the advantages of international specialization, and little change in the distribution of unemployment between nations, and no change in its total amount.

However, there is another incidental result of the decline of international economic relations that is of great importance. Each economy has become more independent of world economic conditions, for a larger part of its production is for the home market. Consequently, each economy is less sensitive to recessions in the production and income of its neighbors, factors over which it has little control. Furthermore, after gaining control of exports and imports through quotas and the rationing of foreign exchange, a nation can embark on a domestic policy of expansion without fear of putting pressure on its currency by causing imports in excess of its ability to export. In other words, a program of tax reduction or public works to stimulate demand and employment can be undertaken regardless of the presence or absence of similar expansionary policies in other economies.

The moral is apparent. The resumption of extensive international economic relations through a general reduction of trade barriers can come about only through an international agreement, and no program of free trade can possibly survive unless every nation assumes the obligation to prevent depression within its borders. For free-trade facilitates not only the passage of goods over national borders, but also the spread of economic disturbance. This important fact explains why in the drafting of the articles of agreement for the Fund many countries, including Great Britain, were dubious about relinquishing their controls over foreign trade in the face of unforseen fluctuations in American income. They finally relented somewhat, under pressure from the United States, and on the hope that we would adopt adequate measures to insure a high national income.

Thus a high and stable level of world income is a prerequisite to the removal of trade and exchange restrictions. Consequently, as Dr. Hoover eloquently pleads, high income should not be awaited as a result of the removal of restrictions. The true contribution of foreign trade to world prosperity is to increase the real income, the value of the goods and services, that can be obtained from *any given level of employment and money income*. This is accomplished through international specialization in production on a basis of comparative efficiency. Generally speaking, the increase of foreign trade from a lowering of trade barriers means a shift of employment from industries competing with foreign imports, such as high-quality textiles, to industries exporting abroad, such as automobiles. The net result will be more goods and services obtainable from the equivalent amount of employment.

During the thirties the amount of foreign trade for most countries was declining not merely in proportion to national income but, as a result of trade restrictions, even faster. High employment throughout the world would cause a great rise in trade over the level of the thirties even without a reduction of trade barriers. A reduction in trade barriers, however, should bring the proportion of foreign trade to national income closer to predepression figures. In the United States exports were 7.1 per cent of national income in 1929 and 4.4 per cent in 1936, the lowest proportion reached; and for the United Kingdom the proportion was 24.7 per cent in 1929 and 16.7 per cent in 1937, a substantial fall. Foreign trade is clearly of much greater importance to England than to us. However, so great is American production and income that our foreign trade is as large as England's in actual volume. Thus by following an intelligent internal economic policy aimed at full employment, we make a very substantial contribution to world prosperity, a conclusion strongly emphasized in the Colmer report.

---

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "International Trade and Domestic Employment," by Calvin B. Hoover, Committee for Economic Development Research Study, McGraw-Hill Book Co., Inc., New York, N. Y., 1945.

House Special Committee on Postwar Economic Policy and Planning, William M. Colmer, Chairman. Sixth Report. "The Postwar Foreign Economic Policy of the United States," 79th Congress, 1st Session, House Report No. 541, Washington, 1945.

All foreign trade and investment data quoted are found in the Colmer report.

In addition to establishing obligations to reduce the controls over trade and exchange, the International Monetary Fund will endeavor to stabilize exchange rates by restricting the right of a member to change them and by furnishing a needed currency to a member temporarily embarrassed. Competitive depreciation of currencies will be prevented, but exchange rates will be allowed to change to meet changed conditions. And when chronic shortages of a currency develop, the Fund will attempt to induce the countries involved to take remedial steps after international consultation. Once again let it be underscored that when trade is largely uncontrolled, these problems are soluble only on an international basis, and the great contribution of the Fund may be a provision for international consultation.

Finally, it should be noted that one of the greatest difficulties in the way of freer international trade, in our meaning of the term, is the rise of semisocialist economic systems and the prevalence of state trading. It is too early to predict to what extent foreign trade abroad will be conducted by state agencies or under state aegis. It should be recalled that much opposition was expressed to the Fund by British socialists who were fearful that government participation in trade would be discouraged. Nevertheless, obligations for removing trade restrictions were included in our loan agreement with Britain. On the other hand, the trade policies of a thoroughgoing collectivist state like Russia are so incompatible with the purposes of the Fund that Russia did not trouble to join. Naturally freedom of trade without private traders is meaningless.

The second method of expanding exports is by investing abroad and creating an export surplus. Indeed, the United States has enjoyed an export surplus for many years financed by investments, and also remittances by immigrants. During the period 1920–1940, we invested nearly seven billion dollars abroad, mostly during the twenties. This is a perfectly normal development in our foreign economic relations. During the nineteenth century we were the recipient of large investment funds from Europe that aided in our industrialization. Now that we have become industrial and wealthy in our turn, we should normally promote the industrialization of more backward countries. Such investment clearly benefits the recipient and should benefit the investor when interest and dividends begin to flow back.

But it is at this point that some confusion has entered the economic analysis of the process, for the backflow of dividends and interest will become larger and larger as more and more is invested until finally it equals the annual net investment abroad, and then the export surplus will disappear. Has the stimulus to domestic employment also disappeared? Neither Dr. Hoover nor the Colmer report faces this question very directly. If we could assume that all the interest and dividends received were spent, the answer would be an unqualified no. For the decline in our exports or the increase in our imports would be exactly counterbalanced in effect by the expenditure of the income from the foreign investment, which is a net addition to national income. But to the extent that part of the income is saved, additional investment will be necessary to offset it. However, this is exactly the same problem that arises when income increases from expanded investment at home or from increased productivity for any reason. It is nothing peculiar to foreign investment. If it should be assumed that one third of the increase in income is saved, then two thirds of the original stimulus from a given rate of foreign investing would remain. In brief, the crucial figure is net foreign investment, not net export surplus in determining the contribution of foreign trade to employment. This net foreign investment should be regarded as an offset to saving on a par with domestic private investment or a government deficit.

Consequently, the importance of foreign investment in supporting a condition of full employment can be approximated by comparing the amount of foreign investment with the amount of saving out of the national income produced at full employment. Using very rough and ready estimates, the savings from this income will probably lie between 14 and 18 billion dollars, while neither the Colmer report nor Dr. Hoover anticipates foreign lending of more than 2 to 3 billion per year. The conclusion is obvious that America must depend for most of its employment and income on domestic investment. Of course, foreign investment can make a very valuable contribution, perhaps a vital one, but it by no means obviates the need for concern over the rate of internal investing.

Two important difficulties confront a program of postwar foreign investment by private investors: The reluctance of private parties in the United States to lend with the memory of past losses in mind, and the reluctance of foreign countries to allow investment accompanied by American influence or control. To consider the first difficulty, the Colmer report points out that actually American investors did not do as badly as commonly thought in the period 1920–1940. At least the total value of American foreign investments in 1940 plus the income received during the period was 22.1 billion, an excess of 8.7 billion over the value of foreign investments in 1920 plus the new investments made during the period. And in condemning foreign investments, one must not forget that domestic investments did not weather the depression years so well either.

The second difficulty may be more portentous. Much of the American investment in foreign countries was made directly by American companies in their own facilities. While this is likely to be the most successful type of foreign investment, it also meets the strongest foreign resistance. In some countries like Soviet Russia it is completely out of the question. Even in mildly socialized economies this kind of investment may be strongly discouraged. Of course, the remaining alternative is to purchase the bonds of foreign governments or the stocks and bonds of foreign companies.

To overcome these problems of postwar international investing, the International Bank for Reconstruction and Development has been established with the membership of most of the United Nations. Most of the activity of this agency will be to reduce the risks on foreign loans by selecting worthwhile projects and guaranteeing loans to finance them. Thus risks on all the loans secured by the agency will be pooled, and the investor need not make an exhaustive study of the particular development he finances. The Bank cannot guarantee loans in excess of its capital which will be about 9 billion dollars, one third to be contributed by this country, but it is anticipated that the loans will be amortized and the Bank's power of guarantee freed for other projects.

It is clear that the restricted capital of the Bank will prevent it from indefinitely expanding the volume of foreign investment. Indeed, the Bank can account for only a small part of, let us say, 2 billions of new investment per year by the United States, and even that for only a few years. The main onus of an extensive program of foreign investment will still have to lie on purely private lending, which cannot function in the absence of settled political conditions.

# BRIEFING THE RECORD

## Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

## Better Prosthetic Devices

A CHALLENGE to American inventors and mechanical engineers to develop better artificial limbs was issued recently by Dr. Paul E. Klopsteg, chairman of the Committee on Prosthetic Devices, through the facilities of the National Inventors Council, Department of Commerce.

Stressing the urgent needs of 17,000 war amputees and an estimated annual minimum of 25,000 civilian amputees, Dr. Klopsteg urged inventors and engineers to submit ideas and suggestions for better prosthetic devices to N.I.C. for analysis and screening.

Acknowledging the ingenuity of American manufacturers in making artificial limbs, Dr. Klopsteg listed the following pressing problems as still requiring solution: (1) There is urgent need for improved ankle, knee, hand, wrist, and elbow-joint mechanisms. Knee and hand mechanisms present the most formidable problems. (2) Materials lighter than those now being used in artificial limbs, but with sufficient strength, must be developed. Wood has long been used. An alloy of aluminum with copper, manganese, and magnesium is widely employed. Laminated plastics are now being tested. (3) New fabrication methods are called for. The choice of materials depends largely on the tools and skills available for fabrication, particularly when individual fittings are required. (4) Until recently, surprisingly little attention has been devoted to a fundamental study of the mechanics of human motion. Further studies need to be made of the motion of joints, of the forces most often encountered in walking and working, and of the statistical distribution of the sizes of body parts. (5) Improved fitting procedures are needed, as are techniques for describing and teaching these procedures.

The Committee on Prosthetic Devices was set up in April, 1945, under the sponsorship of the National Research Council of the Office of Scientific and Research Development. It is now supported jointly by the Army and the Veterans Administration. Consisting of three orthopedic surgeons and three engineers, the committee initiates, supervises, and lends financial support to research institutes and laboratories willing to undertake special research problems for improving prosthetic devices.

The special research programs now being sponsored by the committee include the following: (1) A motion study of normal persons and amputees is being made by means of high-speed x-ray photography. (2) An anthropological study of 2800 persons, representing a cross section of the population, is being made with a view to standardizing artificial limbs and reducing the need for individual fittings. (3) Using slow motion pictures, a study of the motion of joints is being made. Stainless-steel pins are inserted into the leg bones under local anesthesia. Ping-pong balls are attached to the protruding ends of the pins and photographed. (4) The tiny action currents set up in muscles during use are being studied to determine the sequence of muscular operation in walking. (5) Other studies are concerned with a controlled rotary wrist mechanism; a hand which will combine the utility of a split hook with better appearance; a knee that will bear weight when flexed; and better ankle mechanisms and feet.

Members of the committee have prepared a report especially for engineers and inventors, summarizing its work over the past year and analyzing problems as yet unsolved. A mimeographed copy of the report will be mailed free of charge upon request to the National Inventors Council.

N.I.C. is co-operating with the committee by soliciting and screening ideas, suggestions, and inventions for improving prosthetic devices. Proposals submitted to N.I.C. by engineers and inventors are carefully analyzed. If found meritorious, they will be forwarded to the Committee on Prosthetic Devices for further investigation and development. Such proposals should be addressed to John C. Green, chief engineer, National Inventors Council, Department of Commerce, Washington 25, D. C.

## Powdered Metal Welding

REPLACEMENT of the conventional welding rod by a spray of powdered metal is the basis of a newly developed welding technique announced by Powder Weld Co., Brooklyn, N. Y., according to *The Iron Age*, June 20, 1946. Said to be entirely different from any other welding method, the system opens up new fields in welding and metal and plastic surfacing. The equipment consists of a torch made in the general form of an ordinary welding torch, but having a special nozzle and 16 independent controls, many of them at the handle of the tool; a control box with air- and gas-pressure-regulating valves, and a canister from which powdered materials are fed through the flame. The flame is generated and controlled by preselected combinations of gases and air.

The use of this system is somewhat restricted at the present time, due to the fact that there are not many powdered metals available suitable to such use. But with such materials as are available, as well as with some which were specially prepared for experimental use, very interesting results have been achieved in welding, brazing, hard-surfacing, and plastic-surfacing. Among the materials used are lead, tin, zinc, cadmium, aluminum, copper, iron, magnesium, manganese, nickel, silver, and alloys of these metals containing beryllium, bismuth, carbon, cobalt, molybdenum, and tungsten. In addition, various metallic oxides and plastic compositions have been used, as well as glass-forming compounds which result in enamels and glazed coatings.

In actual use the required material is thoroughly mixed with a predetermined amount of flux and placed in the canister of the control box. Gas pressure feeds this through the torch tip and the amount may be precisely regulated by one of the valves on the torch handle. This permits control of the amount of mixture used per minute or per inch of weld. Flame temperature is similarly controlled by adjusting the fuel gas-air mixture as in a conventional torch, by means of valves in the handle. A fourth control in the handle permits regulation of the cooling or processing gas which surrounds the flame cone and forms a controlled atmosphere. By proper regulation of these controls it is possible to regulate the temperature of the alloy, plastic, or other material projected, as well as the temperature of the workpiece. Since both workpiece and material temperatures are controlled by the operator, a variety of results are possible from high-quality bonded hard surfacing, welding, and brazing to dry application of metal similar to ordinary metal spraying.

If desired, the torch may be used for welding or brazing with conventional rod or wire, but eliminating separate flux application. The flux may be deposited in powdered form through the flame at exactly the desired point and in exactly the required quantity. The flux must be used dry, thereby eliminating liquids that might cause oxidation.

The lack of commercially available powdered metals, particularly alloys, has tended to restrict the application of this method to hard-facing operations, and considerable success has been achieved with certain alloys that are so hard that no practical method had previously been available for their application. It is expected, however, that as other metals are made available the method will spread into increasingly wider use, particularly since there are no restrictions as to welding positions. The fact that the weld metal and flux are supplied under pressure eliminates the necessity for confining the process to downhand welding.

## Research and Engineering Center

THE Ford Motor Company, it was revealed recently, plans to start construction, as soon as regulations permit, on a new research and engineering center in Dearborn, Mich., which it is said will be one of the largest developments of its kind in industry.

The project will take eight years to complete and it is estimated that the total cost in construction and equipment will be $50,000,000. It will be located on a 500-acre tract west of Dearborn Inn, and will comprise a primary group of eight buildings bringing into close geographical relationship all research, development, and engineering activities for the company's Ford, Mercury, and Lincoln divisions. These eight buildings will be grouped around an artificial lake 800 ft long and 350 ft wide. The buildings will be of modern design featuring steel and concrete construction and limestone facings throughout.

The new center will be dedicated to Henry Ford, member A.S.M.E., who fifty years ago drove the first Ford car through downtown Detroit, and to the memory of Edsel B. Ford.

Behind this large expenditure is the determination to use every aid which science and research can give in order to make more and better motor cars at prices that more and more people can afford.

Research and engineering work on the mechanical problems of the automobile business will absorb the largest portions of space and budget in the new center. But there are many other areas upon which the spotlight of scientific research must be turned in the constant attempt to increase the efficiency of mass production and mass distribution.

In commenting on one of the most important of those areas, at the annual meeting of the Society of Automotive Engineers early this year, Henry Ford II said that the mechanics of mass production can still be greatly improved, and they can be more widely adapted. But there is a whole vast area in which we are only beginning to make significant progress—what might be called the field of human engineering. Machines alone do not give mass production. Mass production is achieved by both machines and men. And while we have gone a long way toward perfecting mechanical operations we have not successfully written into the equation whatever complex factor represents man, the human element.

Mr. Ford suggested therefore that we try to rewrite the equations to take into account the human factor. If the problem of human relations in industrial production can be solved it is believed that much progress toward lower costs can be made during the next 10 years as was made during the past quarter century through the development of the machinery of mass production.

This is one of the many important problems to be tackled at the new research center. It is a problem for research. It is necessary to know more about the "human equation" in making things as well as the human equation in buying things.

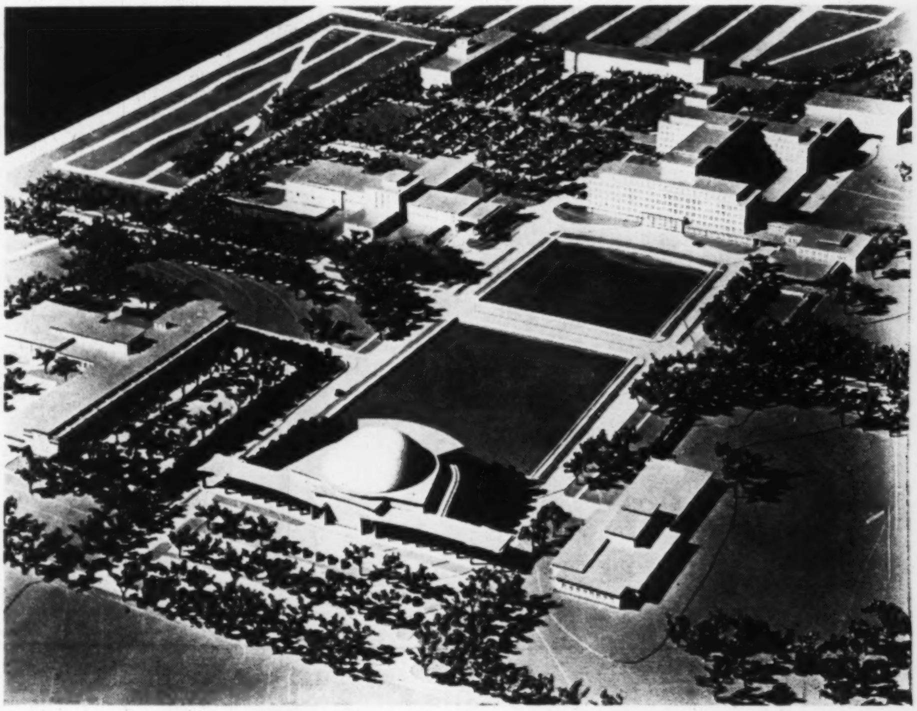


FIG. 1 GENERAL VIEW OF THE NEW FORD RESEARCH AND ENGINEERING CENTER

(The dome-shaped structure in the foreground is the Engineering Exhibit Building. The School is at the right and the Styling Building at the left. The distinctive cross-shaped structure, top left, is easily identified as the Dynamometer (Engine Test) Building. The Administration and Main Engineering Building is situated opposite the domed structure.)

# Heat-Treated Rivets

An article by N. L. Marvin, Pheoll Manufacturing Company, entitled, "Heat-Treated Rivets for High-Strength Joints," appearing in the June, 1946, issue of *Materials and Methods*, reveals that an alloy-steel rivet has been devised which permits heat-treating to high strength of the load-carrying part of the rivet, and of cold-swaging an aluminum-alloy collar into place to complete the fastening. The aluminum collar permits the deformation necessary for riveting, and the heat-treated body of the rivet is not altered by the operation.

This type of heat-treated rivet was developed by engineers of North American Aviation, Inc., to meet the need for a fastening of high strength and low weight for critical locations in airframes. Its success led to adoption by most manufacturers for use with engine mounts, wing spars, vertical and horizontal stabilizers, fire-walls, and similar assemblies. Used originally for military aircraft, it is now going into commercial planes, automobile truck trailers, and other civilian items. Patents are held by North American Aviation, Inc.

The rivet consists of an alloy-steel pin, headed at one end, and with a groove and cutting edge machined in the other, and an aluminum-alloy collar which fits over the grooved end of the pin. The pin is made of A4037 steel, ordinarily, although it can be supplied in stainless steel if desired. It is cadmium-plated to provide corrosion resistance. The collar is A17S-T aluminum, anodized to increase corrosion resistance, and waxed to facilitate swaging under the riveting gun. The alloy-steel pin is heat-treated to a tensile strength of 125,000 to 150,000 psi. The rivet is designed primarily for high resistance to shear, which is the controlling stress in most riveting applications. Using the tensile strength of 125,000 psi as a working minimum, shear strengths of 75,000 psi would be developed and this value is used for design purposes.

Because the relatively soft aluminum-alloy collar is the only part of the rivet to undergo deformation during the riveting process, lightweight equipment can be used for even the larger sizes. The ordinary riveting gun is fitted with a special set differing from the usual rivet upsetting tool only in the design of the collar swaging recess, and in having a discharge port through which the trimmings from the collar are ejected. When rivets are to be placed near the edge of the work, a squeezer device can be substituted for the gun. Reverse riveting can be resorted to when the collar end of the rivet is inaccessible, and for this purpose a special bucking bar is available. The gun is then applied to the head of the rivet.

Using the heat-treated rivets consists simply of dropping the pin into the rivet hole, slipping the aluminum collar over the grooved end, and with a bucking bar supporting the head end of the pin, swaging the collar into the groove. As for any riveting application, it is important that the workpieces be securely clamped or otherwise held together. Installation is reported by the aircraft companies to be from three to five times as fast as with the bolts they replaced, and to show a weight saving of more than 50 per cent over alloy bolts, washers, and nuts formerly used for many critical locations. The cost is also considerably lower than that of the alloy bolt, washer, and nut combination.

Because the aluminum alloy will compensate for irregularities in the surface of the work to a considerable extent, spot-facing and use of shims or washers can be reduced or eliminated. Inclination from the perpendicular of as much as 7 deg will be compensated by the collar without other adjustment. The same adjustment takes place with cylindrical work, unless the radius of the surface is more than three times the diameter of the pin.

Selection of rivets of the proper length is important, since the holding ability of the rivet in tension is dependent upon correct formation of the swaged collar. The cutting edge of the groove which serves to trim off excess metal from the collar during riveting should be $^{1}/_{16}$ in. below the top of the collar. If the cutting edge is higher than this, the aluminum will not fill the groove completely, and if lower, the riveting set will not contact the cutting edge to trim off the excess metal. Variation of $^{1}/_{16}$ in. is allowable.

Removal of the rivets can be accomplished easily without damaging the work. The pin end can be drilled off by using a drill slightly larger than the diameter at the root of the groove.

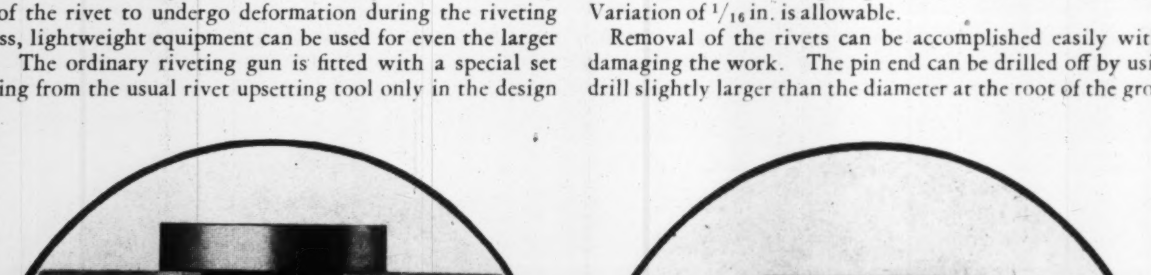


FIG. 2 BEFORE AND AFTER VIEWS OF THE NEW-TYPE RIVET

(That portion of the aluminum collar which remains after the rivet is driven is sheared off to form a smooth head.)

with a drill-out bushing to position it. Splitting the collar, if done carefully, will permit re-use of the pin also. A narrow cape chisel can be used to cut through the collar on opposite sides, or the same effect can be achieved by use of a hollow punch having one or more inside cutting edges, or with special nippers. Any of these methods, if carefully used, will remove the rivet without enlarging the hole. When necessary, removal from the head side can be accomplished by using a drill of the pin diameter in connection with a drill-out bushing.

# Apprenticeship Program for Veterans

IN answer to the growing demand for a comprehensive explanation of how to establish an apprenticeship program and the procedures under the "G. I. Bill" when employing veterans as apprentices, Apprentice-Training Service, U. S. Department of Labor, has issued a 30-page booklet entitled "Setting Up An Apprenticeship Program—A Guide to Employers In Training Veterans For The Skilled Trades."

The booklet explains in detail how to determine the various provisions to include in an apprentice-training program, as well as the steps an employer must take to obtain approval as a qualified "training institution" for veterans, and the steps a veteran must take to derive the benefits of the G. I. Bill.

The booklet contains a complete list of State agencies designated by governors to approve business establishments and educational institutions under the G. I. Bill to train veterans; as well as other State and Federal agencies with which employers will have some dealings in setting up an apprenticeship program. Among other things, the booklet offers a formula on how to allocate training time to the various work processes of a trade; it provides suggestions on wage rates for apprentices, on securing the co-operation of employees, and on procedure to determine appropriate credit on the term of apprenticeship for previous experience.

Copies of this informative booklet may be obtained by writing to Apprentice-Training Service, U. S. Department of Labor, Washington 25, D. C.

# New Soldering Tool

A NEW TYPE of soldering tool with several unusual features has been announced by Durez Plastics and Chemicals, Inc., North Tonawanda, N. Y. Called a "Speedy Iron," the tool is being manufactured by the Weller Manufacturing Co., Easton, Pa.

A wire loop, Fig. 3, replaces the conventional soldering-iron tip. By the application of a new transformer principle, the wire loop is heated to the required soldering temperature five seconds after the trigger switch is pulled. The amount of heat wasted and electricity used are considerably reduced. The small size of the wire tip increases work visibility and allows it to be inserted into small openings.

The soldering gun speeds and simplifies test, repair, maintenance, and service work wherever soldering is done. No time is lost waiting for an iron to heat up, and there is less danger of fire or injury to the user because the gun can be laid on any object almost as soon as the trigger is released.

The housing for this new soldering iron is molded in two halves from a high-impact phenolic plastic which provides insulation against both heat and electricity and keeps the weight of the unit at a minimum.

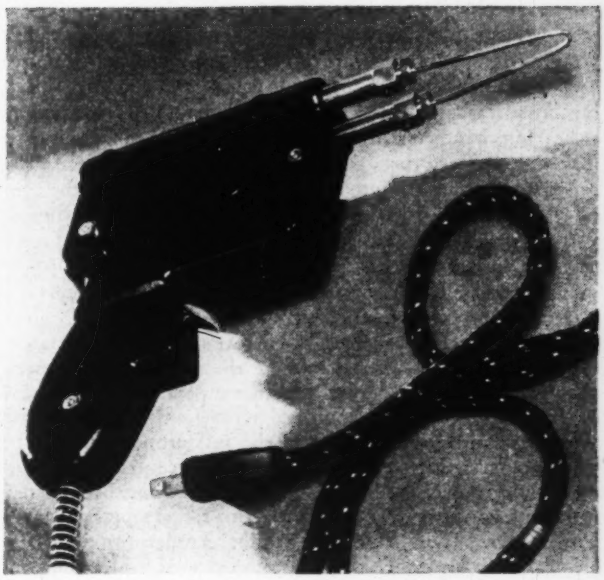


FIG. 3 NEW SOLDERING TOOL

# 18,000-Ton Forging Press

PRODUCTION of magnesium and high-aluminum-alloy forgings of a size previously unattainable is now possible with the installation of an 18,000-ton hydraulic die-forging press in Wyman-Gordon Products Corporation's new $5,000,000 plant at Grafton, Mass. The company, a subsidiary of Wyman-Gordon Co., Worcester, Mass., and Harvey, Ill., is operating the new plant which was designed and engineered especially to house the gigantic machine and its auxiliary equipment, under the Reconstruction Finance Corporation.

The press is described in the June 17, 1946, issue of *Steel*. Termed the largest in the world, the press weighs complete, including motors, pumps, piping, etc., 2050 tons, and was built and installed by Mesta Machine Company, Pittsburgh, Pa. Area of its platen is about 12 × 7 ft; its pressing speed is 360 in. per min.

Constant, quick, and precise control of all operations of the press is its outstanding feature.

The 18,000-ton press will not be used for forging steel or steel alloys. Magnesium and, to a considerable degree, high-strength aluminum alloys, under forging hammers, are brittle and subject to fracture. Thus to attain larger forged parts from these alloys, a need demonstrated in war, this press was built with heat-treating and auxiliary equipment engineered to handle especially these metals.

While it was primarily built to produce larger forgings for aircraft, this equipment will not be used entirely for this purpose but is expected to contribute materially to new civilian uses of magnesium and aluminum alloys.

Three propane-fired, apron conveyer-type forging furnaces supply the press with magnesium or aluminum billets uniformly heated to the proper temperature. Each of these furnaces has a heating chamber 8 ft 6 in. wide × 39 ft long, and a rated output of 4400 lb of magnesium billets per hour.

Furnaces are of the forced-convection type arranged for automatic temperature control in three zones, each zone having an external air-heating chamber and duplicate high-volume, motor-driven, double-wall insulated fans. All air heaters and recirculating fans are mounted on top of the furnace with a platform at both sides to facilitate maintenance of the equipment. A temperature uniformity of plus or minus 2 deg F was secured on the initial test runs—exceptional for equipment of this size.

Propane fuel is burned in radiant tubes equipped with spark plugs for electric ignition. The tubes are installed in the external heating chambers; air is circulated over the tubes and then directed downward through masonry ducts at both sides of the furnace and discharged into the heating chamber under the conveyer. After the air passes through the work, it is returned to the heaters through masonry ducts for reheating. Use of radiant tubes in the external heating chambers eliminates possibility of damage to the surface of billets or forgings due to impingement of combustion products during heating for forging. Each furnace is equipped with a separate motor-driven Spencer blower to provide combustion air for the radiant-tube burners.

Designed to operate at any desired temperature between 250 and 1000 F, furnaces are equipped with Leeds and Northrup automatic temperature control of the full proportioning type with automatic drop correction. Indicating controllers are furnished for each external heater and each work zone, both instruments in each zone working with the same motor-operated control valve. In addition, two 3-point recorders provide a continuous record of temperatures in each external heater and each work zone in each furnace.

High limit control switches are provided in the recorders to close the main fuel valve and sound an alarm in the event of excessive temperature at any of the points recorded.

As additional insurance against excessive temperature conditions, a separate Wheelco Limitrol is used on each zone as an over-all high limit control, to close a solenoid valve to shut off the gas at each zone. Air-flow switches are installed at each fan to shut off the solenoid gas valve at each zone in event either of the fans stop for any reason. A duplex safety shut-off valve also is installed on each furnace to close in case of air, gas, or power failure.

The work, billets or partly formed stock, is carried through the furnace on an apron conveyer consisting of flat bars attached to roller chains. The bars provide a firm support for the work and permit good circulation of air through and around the work. The conveyer is returned under the furnace and supported on wheel track rollers.

To permit maximum flexibility in the plant layout the conveyer is arranged to be driven in either direction. Separate drive units are provided at both ends of the furnace, and unidirectional clutches and interlocked motor controls assure safety of operation in either direction. All motor controls are mounted in an enclosed control center located at one side of each furnace adjacent to the temperature-control panels.

# Pipe-Cutting Attachment

IT takes an experienced operator with a steady hand to make a good square cut on pipe. He must follow the line of cut around the pipe, maintain the proper speed, and keep the nozzle at the correct distance from the work. The July, 1946, issue of *Linde Tips*, describes an attachment, shown in Fig. 4, with which he has only to control the speed. The device guides the blowpipe in a true line, and the nozzle is kept at a constant distance from the work.

The base of the guide is a pipe flange that slips easily over the size of pipe to be cut. If the flange is too loose, steel shims can be welded to the inside at three equidistant points. A boss welded to the flange has a setscrew to prevent the flange from slipping on the pipe. A collar cut from a piece of sheet steel is slipped on the pipe flange. The collar should fit so that it can be rotated around the flange without binding and yet not be too loose. Pins welded to the pipe flange prevent the collar from coming off. A blowpipe holder is made by bending a scrap piece of the sheet steel around the blowpipe like a clamp and bolting it to the wide part of the collar. While the particular blowpipe shown in the photograph is an Oxweld C-48, the guide can easily be adapted to practically any other blowpipe including hand blowpipes, simply by changing the design of the blowpipe holder or clamp.

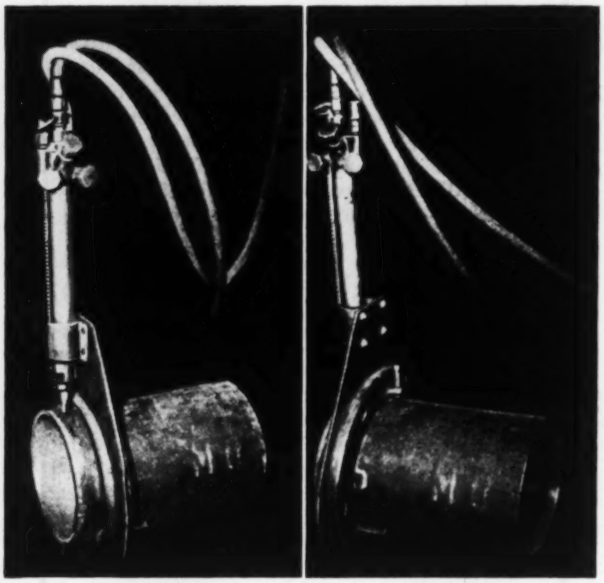


FIG. 4 PIPE-CUTTING ATTACHMENT

In operation the guide is placed on the pipe to be cut, as shown in the illustration. The pipe flange stays in one position and the rest of the attachment is rotated around it.

A device of this kind works best when used only on one size of pipe. It is particularly useful to the small shop that has infrequent occasion to cut pipe of one specific size, or that has a quantity of cuts to make all at once.

# Atomic Plant Transferred

COMMENTING on the War Department's announcement of a contract with the General Electric Company for atomic-energy research and development and the transfer of operations of the Government-owned plant at Hanford, Wash., to the General Electric Company, Charles E. Wilson, president of General Electric, said:

"The General Electric Company was engaged in atomic research for peacetime application before the war. With this background we are convinced that the quickest possible development of nonmilitary applications not only is the most constructive solution to the problem which atomic energy presents to the world, but our greatest opportunity for more jobs and more goods for more people in the future.

"In our Research Laboratory in Schenectady we have already intensified the research, which we began before the war, in fields relating to atomic energy. The Hanford Works is an essential part of any over-all program of continuing research and development in atomic power."

The Hanford Works will be operated by a manager with an advisory committee consisting of H. A. Winne, member A.S.M.E., vice-president in charge of engineering policy; Dr. C. G. Suits, vice-president and director of the G. E. Research Laboratory, and Dr. Zay Jeffries, vice-president and general manager of the G. E. Chemical Department.

## Man-Au-Trol Spacer

PIN-POINT precision in the drilling of holes in metal parts without the use of jigs, and at a saving in time of 20 per cent or better, is now reported possible through a device which has passed exhaustive tests at the Bullard Company in Bridgeport, Conn.

The Man-Au-Trol Spacer, as the device is called, consists of a heavy flat table, which moves either laterally or longitudinally on its base under an accurate drill spindle fixed rigidly in one position. With the work clamped in place, the table is hydraulically traversed from one predetermined position to another by means of two selector controls; one for lateral positions, the other for locating longitudinal positions.

Settings are rapidly and easily made by the adjustment of screws controlling the multiple longitudinal and cross positions of the table, and when once set the platen will constantly repeat to its prearranged settings. Shifting the table from one position to the next is readily accomplished by rotating two handwheels to the dial readings corresponding to that setting for the table. These handwheels control respectively the lengthwise and crosswise motions of the table.

There is one hydraulic cylinder for each longitudinal and transverse motion. Thus if ten cylinders were provided for each of the two directions, there would be 100 positions available. Force from a balanced master cylinder, working in conjunction with the force of any active cylinder, provides a rapid but smooth motion from one location to another and locks the table against its stop.

Hydraulic power to operate the spacer is provided by a self-contained pump operated by a constant-speed motor which is the only electrical equipment required.

To demonstrate the spacer's accuracy, it was set to drill a pattern of four holes in a $^{5}/_{8}$-in-thick square of steel. With one piece finished, the same pattern was drilled independently in another piece of steel of the same size.

One steel plate was placed on top of the other and four steel pins, superfinished to a diameter about 0.0005 in. less than the holes, were inserted. The holes in both pieces matched perfectly. By removing any three pins and rotating one plate on the remaining pin, every possible combination of holes in the plates was tested in the same manner. In each case the pins demonstrated the sliding fit that proved not only the accurate location of each hole, but that each had been drilled in a plane precisely perpendicular to the surface of the steel.

Economies which this spacer will make possible were shown in drilling, reaming, counterboring, and tapping operations of parts for machine tools. One lot of 74 pieces customarily required more than 70 hr for drilling, using a jig. Use of the spacer saved better than 10 hr. The jig, now scrapped, cost close to $350 to fabricate. Another piece, put through in a lot of 134, would ordinarily have required 20 hr. On the pacer 4 hr were saved and the cost of producing the jig—$75—was eliminated. Setup times were included in calculating the results of all tests.

Company engineers attribute these savings to a number of measurable causes. It is difficult, for example, to maneuver the spindle of a radial drill accurately over a hole previously drilled. As a result, the operator customarily changes tools to complete all work on a hole while the spindle is in place. However, the spacer will move the work to a great number of predetermined positions with precision, and make it possible for the operator to use one drill, for instance, until all its work is done before changing to the tap or other tool required to finish the operation.

Where the new device will end the use of drill jigs, the high cost of designing and fabricating them will be gone. Similarly, there will be no problem of jig storage, inventory, inspection, and maintenance, or of delays to production while a jig is being

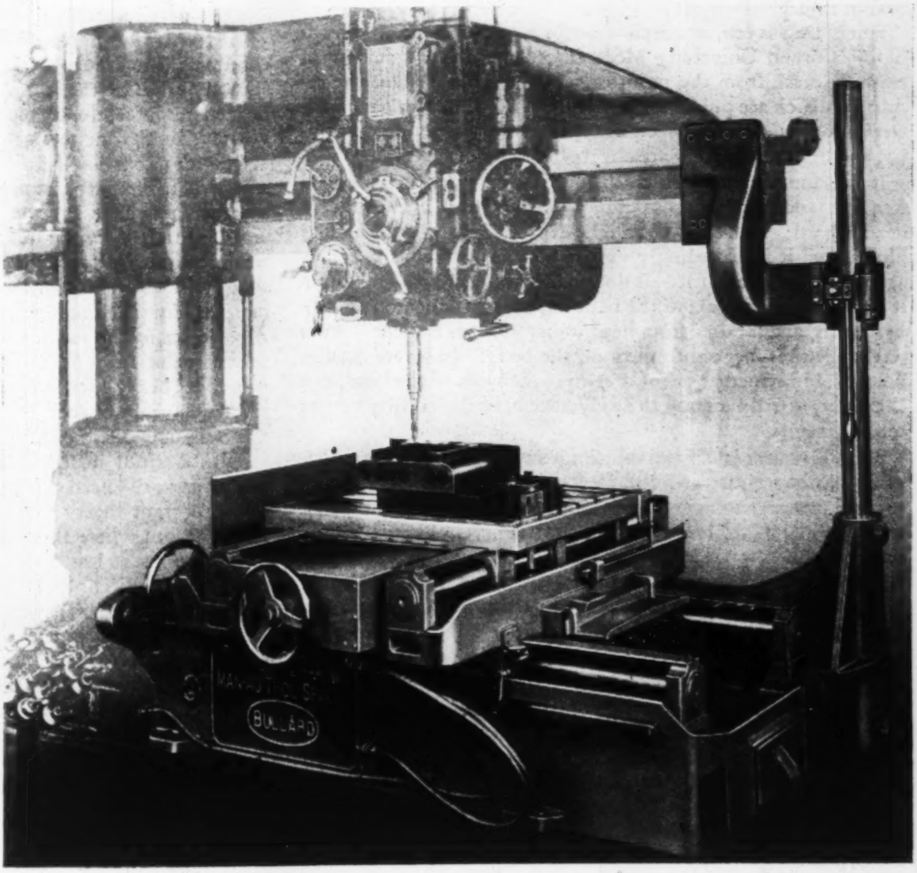


FIG. 5 NEW MAN-AU-TROL SPACER

manufactured. Again, there will be no waiting by an operator while a jig is brought from stores, nor will there be the cost of transporting it to him.

With the spacer, operator fatigue is at a minimum. Since the drilling head is in a fixed position on the rail and the table moves the work effortlessly past the operator while he stands in one position, hand cranking for positioning the tool is eliminated. The handling of jigs by jib cranes or heavy overhead cranes is eliminated.

Inspection likewise becomes simplified. First-piece inspection is all that is necessary. Once a piece has been spotted with the drill and the location of the holes checked by the inspector, the spacer will duplicate that pattern with unfailing accuracy, insuring absolute interchangeability.

The experience of several months has shown that where the Spacer replaced jigs there have been no instances of spacing errors greater than permissible tolerances. During its period of operation at the machine-tool plant no part was ever scrapped because of error in spacing.

The spacer may be applied to various types of drilling machines and will be made in a variety of sizes, from one with a work-carrying table measuring several inches square to others capable of handling massive work.

# Aircraft Cabin Design

THE problem of safety in aviation is not of course primarily one of financial loss. The first consideration of safety is that of injury to people.

Hugh De Haven, research associate, department of physiology, Cornell University Medical College, made a review of crash research from the point of view of cabin design, the results of which are published in the June, 1946, *Aeronautical Engineering Review*. Such subjects as typical injuries, accident analysis, and design for safety are covered in detail.

It was found that of all crash injuries, no typical result is so frequent and dangerous as injury to the head. The human head is hard; its 8 to 10-lb weight exposes it to sledge-hammer blows, and it is exceedingly vulnerable. All its physical characteristics are against it. It dominates accident results. Often it is the only vital part of the body exposed to dangerous injury in a crash, and fatality from head injury alone is not uncommon without other marks of injury on the body. In severe crashes where cabin structure is not destroyed, injuries of the head, not the body, usually dictate the difference between fatality or less serious results.

To offset hazards of head injuries from forward seats in multiplace passenger aircraft, the idea has often been proposed of seating passengers facing aft. This arrangement is now being tried by the U. S. Navy to see whether psychological factors outweigh advantages. By seating passengers aft as far as possible and facing seats toward the rear, chances of safety would be greatly increased. In the event of a crash landing, the heads and bodies of passengers would be fully supported to give "fire-net effects" until the seats or rearward cabin structure failed.

Among survivors in crashes of light planes, analysis has shown that even with high rates of belt failure, injuries to occupants of rear seats are, on the average, 53 per cent less severe than those in forward seats. If the strength of safety-belt assemblies is increased from 1000 to 2000 lb, and if the back of the front seat is made less dangerous, this 53 per cent safety advantage of rearward seats undoubtedly would be increased to an amazing degree and would allow, for the first time, definite judgment of what can be done with safety belts and rearward seating to give optimum protection—not only in private planes but also in military and commercial air transport.

Safe control wheels and safe instrument-panel arrangements are requisite in all ships, but their value is rarely seen in transport aircraft because of a low frequency of accidents in which they alone constitute the principal danger.

In personal aircraft, however, the design of control wheels and instrument panels is a serious safety problem, for they frequently change what might have been a dangerous mishap into a fatal accident.

If all parts of past instrument panels had been made of solid unyielding structure, many of the best men in aviation would not be with us today. Solid areas in panels are not made of cast iron but often are backed up by structure that is just as dangerous. In many aircraft now bidding for popular favor, panels are studded with obvious and needless dangers. Placing a heavy flight instrument or a parking-brake handle or a starter crank in the middle of the panel may seem a minor hazard, but casualties caused by such objects add more fatalities to private flying today than structural failures in the air, fire in the air, and many other dangers that have been offset by improved design.

Modification of head injuries often would result from mere rearrangement and better placement of panel details but the needs of safety in popular flying deserve further thought than this. The panel should not have a hard sharp upper edge. Transverse bracings, tube clusters, and other solid objects should not be immediately behind the panel. It should not be crowded against header tanks; and as much space as possible should be provided between it and forward objects to lessen dangers when collapse of forward sections occurs.

In dealing with the instrument panel and its details, the thought throughout should be of lessening danger for the head should it strike the panel at high impact velocity. With normal resourcefulness, major improvements may be achieved without significant changes in cost, weight, or function.

One idea that has been backed by observations in crash research is to keep the panel facing and the instrument mount separate and have the mount with its heavy instruments so arranged that it can fly forward under heavy crash force. This would eliminate many dangers now caused by panel details that are held in positions where they expose the head to hammerlike blows and inflict fractures of the skull and facial bones. Any object in the panel that can cause danger to the head at impact velocities of 50 ft per sec should be designed to shear free under heavy inertia force before the head strikes. Amazing results have been seen where this happened by chance, and these chances surely can be improved by design.

With a strong ductile panel facing, free of solid objects and projections, the head can be stopped from high velocities without important injury. In other than aircraft accidents, cases are on record where the head has been stopped from velocities of 70 ft per sec in less than 6 in. without skull fracture or loss of consciousness. The skull cannot be fractured against a broad metal surface that will yield and cushion heavy blows, and the evidence today is that, as a cushioning medium, nothing is better than light sheet metal, 0.040 to 0.060 in. in thickness. This appears to be more satisfactory than deep sponge rubber or any other known padding because full energy-absorption begins with the first denting of the surface and continues without seriously increasing peak force or danger. Thus a blow sufficient to cause a $^1/_2$-in. dent in a ductile surface may daze a man, while a 6-in. dent may produce no greater evidence of injury.

Next to the instrument panel, no single detail in personal aircraft needs more safety thought than control-wheel installations. In accidents where the force is not severe and collapse of cabin structure is not even threatened, control wheels alone often cause serious or fatal results. Here, however, the safety problem is complicated, for the wheel is often in different positions to meet varying needs of control just prior to an accident. In some cases the wheels are slammed forward by the force of the crash and are within forward range of the head. In other crashes, collapse of forward sections drives the push-pull tubes into the cabin, ramming the control wheels against the pilot. Evidence indicates that the pilot most often pulls the controls back as far as possible in the last moment of an emergency, for the push-pull tubes frequently are found bent and jammed in this rearward position.

When the wheels slam forward, the head is likely to strike them causing fractures of the skull and facial bones. When they are rammed back, anything can happen; but when they are held back they are in their safest position and occasionally give amazing protection.

The wheels and push-pull tubes should be designed to give definite protection more often. All that seems needed is a rugged resilient wheel to distribute loads on the chest and an inertia gadget to check rapid forward movement of the push-pull tubes. This inertia drag or lock need not be in contact with the tubes under any conditions except those set up by crash force.

If ingeniously designed, the cost and weight of this improvement would be inconsequential as compared with results. Steering wheels in automobiles have been developed to give the driver high degrees of safety. Owners of personal planes surely merit this same protection.

In private aircraft a strong belt and a safety wheel might be better than shoulder harness because of psychological reactions against the use of harness and because we find the harness is not worn routinely in casual flying—even where it is installed.

## Welded Locomotive Boilers

THE American Locomotive Company has announced that welded locomotive boilers are now being built for the first time in United States railroad-equipment history at its shops in Schenectady, N. Y. This important development climaxes nine years of experimental operation of a welded boiler built by American Locomotive in 1937 for a Consolidated-type freight locomotive of the Delaware and Hudson Railroad.

(An article in the July, 1945, issue of MECHANICAL ENGINEERING, pages 619–621, by G. F. Edmonds, describes the fusion-welded boiler. Also in the same issue are two other articles, "Locomotive Boilers—Welded Construction," by James Partington, member A.S.M.E., pages 622–624, and "Prospective Use of Fusion-Welded Locomotive Boilers," by John M. Hall, member A.S.M.E., pages 624 and 629.)

For nine years tests on this experimental installation have been conducted under the supervision of the Interstate Commerce Commission. This boiler has been completely free of leaks during this period and all of the welded seams are still in perfect condition.

R. B. McColl, Alco president, said that the new manufacturing facilities permit the company to build any size welded locomotive boiler as well as locomotives complete with welded-boiler equipment.

One important advance is the use of x-ray apparatus which greatly speeds up detection of flaws in metal. After passing x-ray examination, the boiler is stress-relieved in a furnace large enough to take the boiler as a unit.

It is said that the use of welded locomotive boilers will greatly reduce boiler maintenance costs in railroad shops and will also reduce the time that locomotives are out of service for boiler repairs.

In discussing the experiments which have been conducted for nine years, Mr. McColl said, "Before the first boiler was installed for road service in 1937, it was set up as a stationary boiler and operated for six weeks. Then it was mounted on a locomotive and examined every three months for the first year. All the welded seams were carefully gone over and the second year the same procedure was followed every six months. Subsequently the boiler has been examined once a year and during nine years of operation all of these welded seams have been in perfect condition."

He also has listed several other advantages gained by the use of welded boilers. One is the elimination of riveted joints which sometimes permit seepage between boiler plates even when best fabricating techniques are employed. Boiler leaks are eliminated by welding boilers, removing the possibility of cracked sheets which can be a major maintenance expense.

The smooth contour of the welded boiler permits an easier application of the boiler lagging and jacket and provides an equally smooth surface on the interior. This contributes to more satisfactory washouts by maintenance crews.

On many modern locomotives the saving of weight in the welded design over the riveted one is an important item. Depending upon the type and size of the locomotive, this weight saving may be from 3000 to 6000 lb for the boiler alone, with additional saving in weight of lagging and jacket.

## U. S. Patent System Analyzed

IN a timely analysis entitled "A Review of Proposals for Revision of the United States Patent System," made for the National Association of Manufacturers, George E. Folk reviews every recent legislative proposal to change or improve the patent laws of this country. Included also are numerous reports and findings and recommendations made of the system by various agencies, namely, the Science Advisory Board Committee, the Temporary National Economic Committee, and the National Patent Planning Commission.

Copies of this pamphlet are available from The National Association of Manufacturers, 14 West 49th Street, New York 20, N. Y.

## German "V2" Rocket Bomb

IN Germany, modern rocket development started seriously around 1929 and experiments were begun by a group of private individuals interested in the subject. About 1933 the work attracted the attention of the Weapons Department of the German Government and was virtually taken over by them. In 1937 there was set up at Peenemunde a rocket experimental establishment, at a cost of approximately 300,000,000 marks; and the work which was previously carried out in Berlin was transferred there. It was there that the "A4" rocket—the "V2" as we know it—was developed.

The Institution of Mechanical Engineers *Journal and Proceedings* for June, 1946, contains the text of an informal discussion on "The Mechanism of the German Rocket Bomb (V2)," with an introduction by W. G. A. Perring, deputy director (Research and Experiment), Royal Aircraft Establishment, Farnborough, England, which offers some interesting data and information concerning these rockets. Twenty-three figures illustrate the article.

The A4 (V2) rocket was begun about 1939–1940, and the first successful launching was in October, 1942. The first A4 rocket the Germans attempted to launch exploded on the ground and blew up the experimental unit concerned; the second went up a few feet and did the same; the third rose some 15,000 ft and exploded in the air; but the fourth flew about 170 km and demonstrated the possibilities of long-range rockets.

The V2 rocket is roughly 46 ft long. The diameter of the body is about 5 ft 6 in., and the diameter over the stabilizing fins at the rear end is 11 ft 8 in. It has an initial weight at launching of 12.5 tons, of which more than two thirds is fuel, and it carries a war head of nearly a ton.

Fig. 6 shows how the interior of the rocket is subdivided. The war head occupies roughly the first 5 ft 11 in. of the weapon. It is conical in shape, made of mild steel about $^1/_4$ in. thick, and is filled with Amatol. The total weight of the war head and its case is roughly 2150 lb.

Immediately behind the war head is a compartment subdivided by partitioning into four quadrants housing the automatic pilot and control gear. The outside skin of the rocket in the vicinity of the instrument compartment is formed in such a way that the instruments can be readily serviced; and since they had to be serviced almost up to the last minute, accessibility was important.

Behind the instrument bay are the fuel tanks. There are two tanks, each of about 150 cu ft capacity; the one at the front end contains alcohol, to which a certain amount of water was added, and the second tank, at the rear, contains the liquid oxygen. This compartment forms the main central compartment and is about 20 ft in length.

Toward the rear of the rocket are the pumps which provided the means of driving the fuel into the combustion chamber, and finally there is the combustion chamber itself and the exit Venturi.

Around the Venturi are the stabilizing fins. Four pad pieces carry the internal controllers, which are used for stabilizing the rocket in its flight and for controlling it during flight. In addition there are four small external controllers, one on each of the stabilizing fins.

In general, most of the structure of the rocket was built on the lines of aircraft construction, with stringers and formers. The skin itself was of mild steel, about 0.025 in. thick, and the strength throughout the rocket was proportioned by spacing and varying the thickness of the stringers supporting the skin.

Fig. 7 shows diagrammatically the rear end of the rocket with the combustion chamber and Venturi and part of the

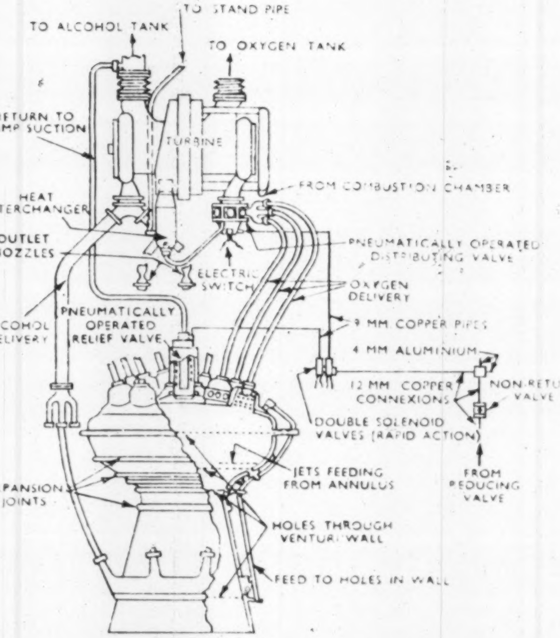

TO STAND PIPE
TO ALCOHOL TANK
TO OXYGEN TANK
RETURN TO PUMP SUCTION
TURBINE
FROM COMBUSTION CHAMBER
HEAT INTERCHANGER
OUTLET NOZZLES
PNEUMATICALLY OPERATED DISTRIBUTING VALVE
ELECTRIC SWITCH
OXYGEN DELIVERY
PNEUMATICALLY OPERATED RELIEF VALVE
ALCOHOL DELIVERY
9 MM COPPER PIPES
4 MM ALUMINIUM
12 MM COPPER CONNEXIONS
NON-RETURN VALVE
DOUBLE SOLENOID VALVES (RAPID ACTION)
JETS FEEDING FROM ANNULUS
FROM REDUCING VALVE
EXPANSION JOINTS
HOLES THROUGH VENTURI WALL
FEED TO HOLES IN WALL

FIG. 7 DIAGRAMMATIC ARRANGEMENT OF PUMPS AND BURNERS

pumping system. The auxiliary power unit comprises a steam turbine which drives two centrifugal pumps. The pumps draw the fuel from the tanks and convey it to the combustion chamber through a distributing system. The alcohol acts not only as the fuel but also as a coolant and is led from the pump to an annulus at the rear of the Venturi; it then feeds back through the Venturi skin, which is double, to a distribution valve, and then outward to the mixing cups. The oxygen is fed down by another system of pipes to the eighteen mixing cups and is then sprayed through a brass rose located centrally in them.

The method of delivering the fuel and driving the pumps is quite interesting. The generating plant which provides the gases, Fig. 8, to drive the turbine—and therefore the pumps—comprises a container of hydrogen peroxide, and a container of permanganate. These fuels are driven under pressure, supplied by nitrogen bottles, into a mixing chamber where a mixture, mainly steam, is produced at 420 C (788 F) and 350 psi pressure.

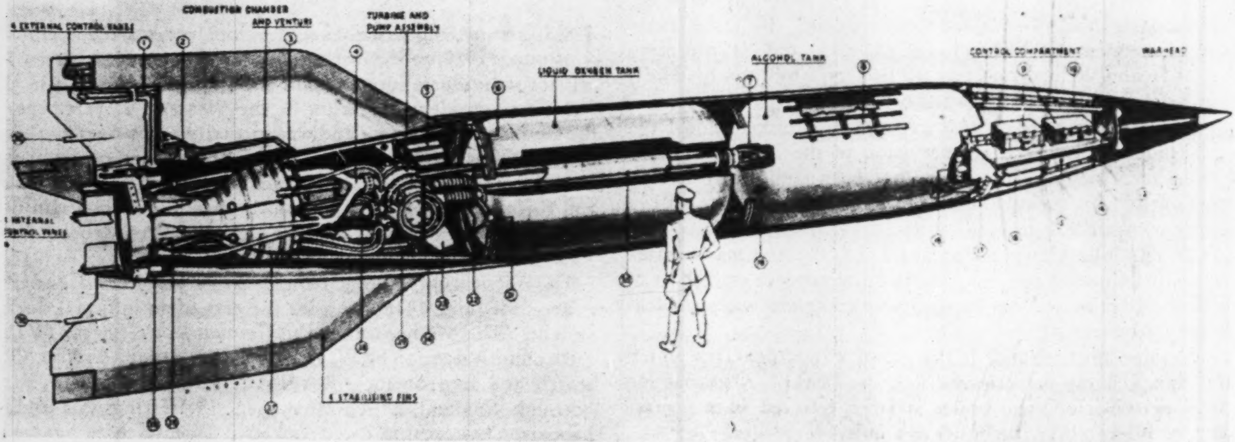

4 EXTERNAL CONTROL VANES
COMBUSTION CHAMBER AND VENTURI
TURBINE AND PUMP ASSEMBLY
LIQUID OXYGEN TANK
ALCOHOL TANK
CONTROL COMPARTMENT
WARHEAD
4 INTERNAL CONTROL VANES
4 STABILISING FINS

FIG. 6 ARRANGEMENT OF INTERIOR OF ROCKET

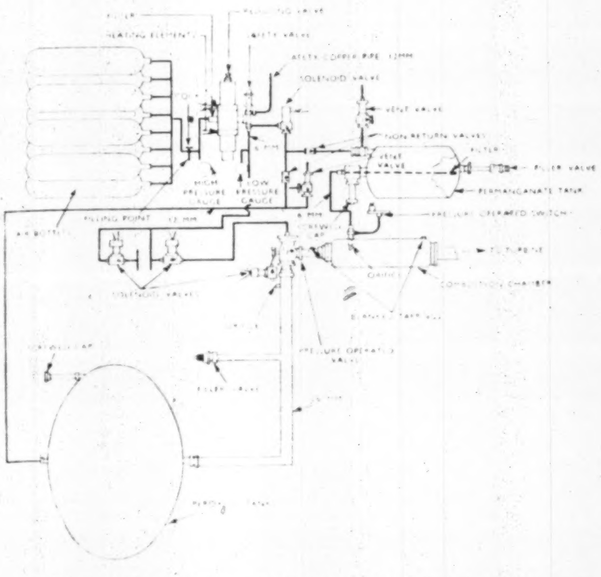


FIG. 8 DIAGRAMMATIC ARRANGEMENT OF AUXILIARY SYSTEM

The steam is then fed to the turbine—a simple single-wheel arrangement, having partial admission, which develops about 500–600 hp at 5000 rpm.

The following figures show roughly the working conditions of the rocket. The pressure in the combustion chamber corresponding to 15 psi pressure at exit is 300 psi, and the pressure in the Venturi throat is about 150 psi. The temperature of the gases in the combustion chamber is about 3000 C abs (about 5430 F) and this drops to about 1650 C abs (about 3000 F) at the exit. The velocity which, of course, is initially zero in the combustion chamber, rises steadily, and at the throat is 2000 ft per sec, and at exit reaches about 7000 ft per sec.

Despite the very high temperatures in the combustion chamber, it was interesting to find that the Germans were able to use mild steel. The worst conditions might be expected near the throat area. A careful examination was made of a number of Venturi tubes, and from this evidence it was found that the skin temperature was never more than about 950 C (about 1740 F), nor were any signs of distress found; the cooling therefore did its job excellently. The only sign of trouble which was noticed concerned expansion troubles.

The shape of the trajectory is shown in Fig. 9. The rocket is fired vertically when standing up on its end. After firing, the rocket is turned so that it moves toward the target along a path of the type shown in the figure. At some point about 22 miles above the earth's surface the fuel is either cut off or exhausted, and the rocket then proceeds along a roughly parabolic arc until it descends into the denser air and the path steepens slightly.

Over the first part of its upward course the rocket acceleration steadily increases as the fuel is burned and the rocket weight decreases. Acceleration increases until the "all-burned" stage; the velocity therefore reaches a maximum at that point and then decreases as the rocket moves up in space. After passing the top of the trajectory the velocity again increases, but as the rocket descends into the denser air the velocity again decreases. The maximum velocity at the all-burned stage is approximately 5000 ft per sec, i.e., about 3400 mph. Particulars of the velocity over the trajectory are shown in Fig. 9.

As the rocket leaves the ground the Venturi is producing about 60,000 lb of thrust. The weight of the rocket is of the order of $12^{1}/_{2}$ tons, or 28,000 lb; the rocket therefore commences to move upward with a net acceleration of 1 *g*, i.e., at the same rate as a body falling freely. As the fuel is exhausted the acceleration increases, and by the time the fuel is nearly exhausted the weight of the rocket has fallen to about 6000 or 7000 lb and the thrust has increased slightly, with the result that the acceleration has increased to about 8 *g*. In other words, the structure of the rocket is experiencing a force of roughly eight times its own weight. In aeronautical work this condition would not be regarded as very serious.

Another interesting point is that at the end of the all-burned stage, when the velocity has reached about 5000 ft per sec, the stagnation temperature is in the region of 1400 C abs (about 3040 F). The skin temperature of the rocket should approach the stagnation temperature and it would therefore become very hot. A careful examination of the skin condition of a number of rockets was made, but no evidence was found to show that it ever reached a temperature of more than about 650 C (about 1200 F). The skin temperature is therefore well removed from the stagnation temperature which might have been expected. The explanation probably lies in the fact that conduction plays an important part in keeping the temperature down; but the effect of radiation is perhaps even more important at these high temperatures. The radiation losses vary as the fourth power of the temperature and these losses exert an important influence in keeping down the skin temperature. Nevertheless, it is obvious from the fact that the skin does reach temperatures of the order of 650 C, i.e., about 1200 F (perhaps a dull red), that at night it might have been possible to see the rocket.

The Germans had themselves been concerned about the possible high temperatures which would be reached by the skin and had carried out a very interesting set of experiments to explore skin conditions. Into the skin of the rocket metal plugs had been inserted which had low melting points. These plugs were coupled through electric circuits into radio equipment which telemetered the results to the ground. As the result of this work the Germans concluded that nowhere on the rocket had the temperature ever reached more than about 600 C (about 1100 F), a result that agrees very closely with Allied examination of the surface of the rocket, the state of the paint conditions, and the metallurgical conditions of the metal in the skin.

In regard to the distribution of the weight, it was mentioned that the war head accounted for 2150 lb; and naturally the fuel forms a very large proportion of the total weight. It is, in fact, the amount of weight that can be devoted to fuel which really governs the range of the rocket. In the case of the V2 rocket, roughly 19,000 lb, or more than two thirds of the total weight, has been given to fuel. This is a very large proportion,

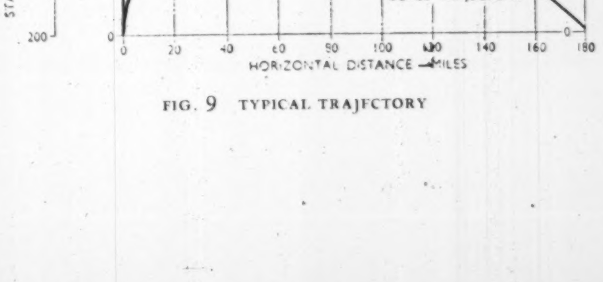


FIG. 9 TYPICAL TRAJECTORY

and it is of interest to compare the weight distribution of the rocket with the weight distribution of, say, a high-speed bomber, and with the V1 flying bomb (Table 1).

TABLE 1 COMPARATIVE DATA OF HIGH-SPEED BOMBER, FLYING BOMB (V1) AND ROCKET BOMB (V2)

| Item | Fast bomber | V1 | V2 |
|---|---|---|---|
| | Percentage weights | | |
| Structure | 29 | 25 | 13 |
| Power plant | 24 | 8 | 8 |
| Fuel | 19 | 19 | 69 |
| Equipment | 13 | 1 | 2 |
| Pay load | 16 | 46 | 8 |
| | Speeds, miles per hour | | |
| Take-off | 120 | 200 | 0 |
| Maximum | 400 | 350–400 | 3400 |
| | Other data | | |
| Ceiling (feet) | 40,000 | 9000 | 350,000 |
| Range (miles) | 1600 | 175 | 220 |
| Endurance | 6.5 hours | 30 minutes | 5.0 minutes |
| Fuel consumption (lb per sec) | 0.57 | 0.66 | 275 |
| Fuel consumption (lb per hp-hr) | 0.75 | 4.3 | 1.6 (when near all-burned stage) |

# Acid Pumps

THE growing need for reliable and economical acid pumps for the chemical industry presents many interesting and difficult problems, according to an article by J. Sprecher, which appeared in the *Sulzer Technical Review*, No. 3, 1945. Apart from difficulties connected with viscosity, pulpiness, and deposits, the main problem lies in the choice of an economical, chemical-resistant material having good machinability. A suitable material resistant to the majority of chemicals and of satisfactory strength and machinability, is yet to be found. Careful choice of available materials is necessary, for certain chemicals must not contain metal traces while others may safely contain certain impurities.

New chemical processes require actual operating tests with various materials, since changes in composition of the chemical, different operating conditions, and higher flow velocities may make previous experiences inapplicable.

According to price and machinability the complete pump or only the parts in contact with the liquid are made of acid-resistant material. Sometimes corrosion-resistance is achieved by coating the working components with protective material. Brittle shock-sensitive materials are supported in cast-iron frames which take up the mechanical stresses.

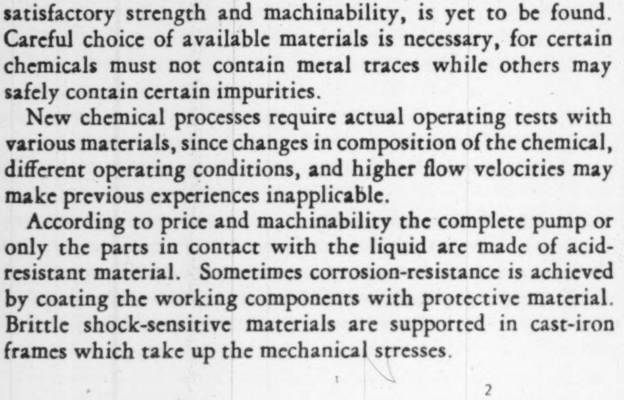


FIG. 10 STANDARD PUMP FOR CORROSIVE LIQUIDS

[(1) Incoming liquid. (2) Outgoing liquid. (3) Impeller. (4) Perforations in impeller (for pressure equalization). (5) Stuffing-box packing. (6) Stuffing-box gland. (7) Interchangeable sleeve. (8) Drain pipe for seepage liquid.]

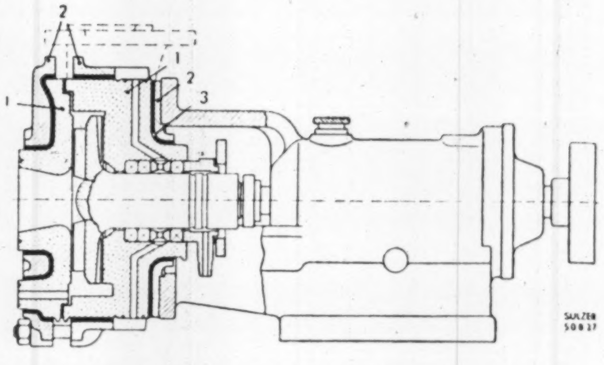


FIG. 11 ACID PUMP OF STONEWARE WITH EXTERNAL PARTS OF CAST IRON

[(1) Internal parts of stoneware. (2) External parts of cast iron. (3) Cement.]

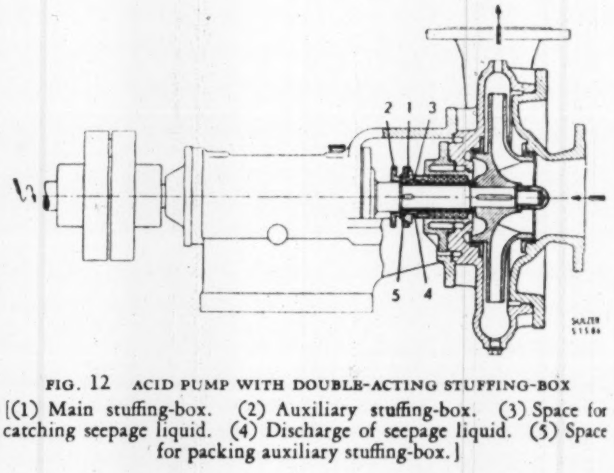


FIG. 12 ACID PUMP WITH DOUBLE-ACTING STUFFING-BOX

[(1) Main stuffing-box. (2) Auxiliary stuffing-box. (3) Space for catching seepage liquid. (4) Discharge of seepage liquid. (5) Space for packing auxiliary stuffing-box.]

For noncorrosive and mildly corrosive chemicals, cast-iron pumps for low and medium pressures are used.

For more highly corrosive liquids, pumps built from chromium-nickel-steel, bronze, lead, light alloys, cast steel, acid-resistant silicon cast iron, and rubber-coated cast iron are supplied. Impellers have a small number of blades and have proved successful for normal pure liquids and also for those containing mud or fibers, or tending to crystal formation.

Apart from these standard pumps, a series of special types have been developed, namely, vertical pumps, pumps without stuffing-boxes, and self-priming pumps for volatile liquids which, however, are suitable only for liquids free from mud, fibers, crystals, etc.

Fig. 10 shows a standard Sulzer acid pump for liquids with a fairly marked corrosive action. This differs from the water pumps by having a long, accessible, stuffing-box easy to replace. Maximum drip and splash protection is afforded and liquid trickling through is caught and extracted through pipe (8). A replaceable sleeve protects the shaft well beyond the gland. The pump is overhung to protect the bedplate and bearing from the corrosive liquid handled.

In another type the nature of the chemical required the use of silicon cast iron which possesses low impact and tensile strength. The components are built into a strong cast-iron frame to protect them from these mechanical stresses. The shaft is screwed into a central iron hub which is cast integral with the silicon-cast-iron impeller which is extremely hard and brittle and can be machined by grinding only. Silicon cast iron

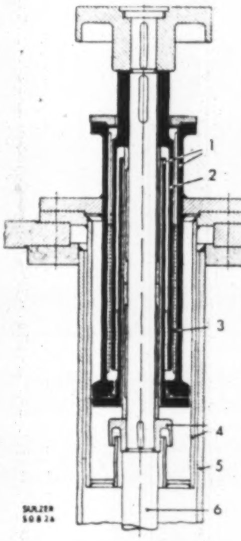


FIG. 13 STUFFING-BOX FOR VERTICAL ACID PUMPS WITH MERCURY AS SEALING MEDIUM

[(1) Cup holding mercury. (2) Sealing piece fixed to shaft and rotating with it. (3) Mercury. (4) Parts of device for catching dripping mercury. (5) Supporting pipe. (6) Transmission shaft.]

offers high chemical resistance, but cannot withstand high temperatures and is sensitive to temperature changes.

Similar pumps are built with hard lead components which have low mechanical strength and necessitate the use of heavy sections and cast-iron supporting frames. Lead- and rubber-coated cast-iron parts are also employed in some pumps.

A vertical acid pump is also built, consisting of a motor mounted on a base plate and a pump suspended by a tube below the base. The transmission shaft runs in bearings inside the tube, while the pressure outlet pipe is led upward separately.

Stoneware, porcelain, and glass are in general acid-resistant, being attacked only by hydrofluoric acid. Fig. 11 shows a stoneware centrifugal pump. The stoneware, which serves to protect the metal from chemical attack, is cemented into cast-iron components which take up the mechanical stresses.

Lead and rubber are also used as protective coatings against chemical attack. The rubber must be absolutely free from pores, a property which can be easily checked by measuring its electrical conductivity. Other pumps employ plastic materials. Such pumps require complicated methods of construction and may be injurious to hydraulic efficiency.

The most primitive method of conducting off the acid trickling through a stuffing box is to catch the liquid in a large drip pan placed beneath. From this the liquid can easily be removed.

A more effective way is to use the double stuffing-box design shown in Fig. 12. A seepage chamber in the main stuffing box (1) catches the escaping liquids. A pipe at (4) (not shown) by-passes it. The effect may be further improved by the employment of reverse blading.

In some cases a weak alkali sealing liquid can be introduced into the space (5) for the purpose of neutralizing escaping liquid. Fig. 13 shows a stuffing-box design for vertical acid pumps employing a mercury seal. A stationary and a revolving sleeve dip into a fixed mercury cup.

With single-inlet overhung impellers the stuffing box is not subjected to discharge pressure, since pressure-equalizing holes are provided in the impeller. However, there is a danger of air entering through the gland during operation or starting up when subatmospheric pressures occur on the suction side. This may be avoided by adjusting the sluice valve in the suction line and by proper dimensioning of the pressure-equalizing holes and packing-ring clearances. Entry of air usually results in corrosion and inefficient working of the pump.

A further means of relieving the stuffing box is the reverse blading seen in Fig. 14. This is designed to relieve the stuffing-box pressure while running without danger of air entering. Fig. 14 also illustrates an acid pump without a stuffing box. At rest the impeller is pressed against a sealing bush (1) provided in the pump cover by a spring at the shaft bearing. When rotation begins a centrifugal device overcomes the spring pressure and raises the impeller from its seat. In order to prevent liquid from escaping along the shaft after full speed of rotation has been reached, the reverse side of the impeller is equipped with the blading (2) which keeps the delivery liquid away from the shaft.

# Egyptian Hydroelectric Station

At a press conference held in the Hotel Waldorf-Astoria, New York, N. Y., Aug. 2, 1946, The Hydroelectric Power Commission of the Egyptian Government revealed that it planned to visit American companies which will offer bids on the building of a hydroelectric station at the Aswan Dam on the Nile River, 500 miles south of Cairo. Invitations for tenders were also extended to Great Britain, Switzerland, France, Sweden, and Russia.

The cost of building the station has been estimated at approximately $40,000,000, excluding the transmission, which it is estimated will cost an additional $40,000,000. Output to be obtained from the project will be 280,000 kv.

Members of the Commission appointed by the Government of Egypt are: Dr. Abdel Aziz Bey Ahmed, chairman, who is also director of the Hydroelectric Power Department of Egypt; Mustafa Bey Fathy, undersecretary of the Ministry of Public Works; A. Khairy Bey, director of Reservoirs, Ministry of Public Works; and Geoffrey F. Kennedy, member A.S.M.E., partner in the London firm of Kennedy and Donkin, consulting engineers.

The Aswan Dam is the first water-power project to be developed by the commission. This will be followed by projects for the development of power available from the various barrages on the Nile which will be linked up with the present scheme.

Another water-power development which the commission is studying is the development of what is known as the Quattara Hydroelectric Scheme, which it is said will be the most unique in the world.

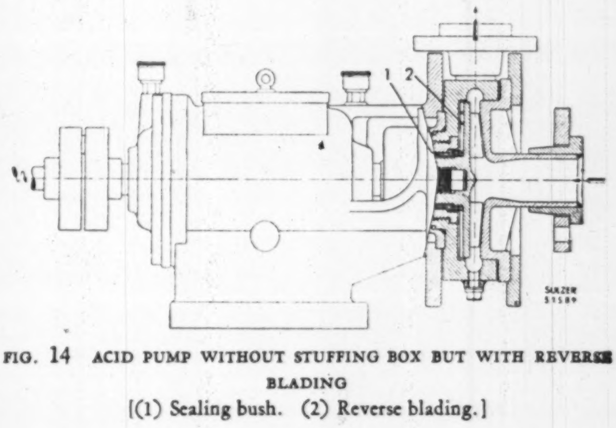


FIG. 14 ACID PUMP WITHOUT STUFFING BOX BUT WITH REVERSE BLADING

[(1) Sealing bush. (2) Reverse blading.]

Dr. Ahmed said that he and the commission will take advantage of their visit to the United States to enlist the interest of firms concerned with the class of work which this project involves.

The Quattara is a huge depression lying west of the Delta, covering an area of about 770 sq mi. Its lowest point is 450 ft below sea level. The project consists of making a cutting from the Mediterranean to the depression and generating power from the influx of salt water into the depression. The cutting will consist partly of an open channel about 12 miles long and a tunnel about 28 miles long. The hydroelectric station would be placed 165 ft below sea level and the incoming water will be disposed of by evaporation from the lake thus created.

The American Society of Mechanical Engineers, through Stewart E. Reimel, secretary to the Committee on International Relations, has been co-operating with members of the commission, helping them prepare an itinerary and offering advice which will help them accomplish their mission here. Arrangements have been made for the commission to visit, among other projects, the Tennessee Valley Authority, Boulder Dam, Shasta Dam, Grand Coulee Dam, Bonneville, Niagara Falls, Muscle Shoals, and the Shipsaw Development in Quebec.

## Accident Cause Classification

THE work of accident prevention, as in all other complex and extensive activities, requires at least a minimum of so-called paper work, so that the safety engineer may know where his accidents are happening and where there is greatest need for corrective action.

In a talk which he gave at the Texas Safety Conference, Galveston, Texas, recently, Edward R. Granniss, member A.S.M.E., director, Industrial Division, National Conservation Bureau, pointed out that paper work is justifiable.

A survey made of an Army installation is an excellent illustration of how the value of paper work was not fully appreciated. Accidents at this post were investigated properly and the pertinent facts of occurrence were recorded and summarized. However, no use was made of the summaries, except to forward them as required to the next-higher supervisory office.

When asked why he prepared these summaries, the Safety Director replied, "Because Washington requires it."

In this example the Safety Director, who in many ways was doing excellent work, complained about insufficient help to cover the huge far-flung installation. He was conscientious but, like a hen in a rainstorm, he scurried from place to place, from hazard to hazard, scattering and diffusing his corrective action so widely as to decrease greatly its effectiveness.

A few minutes spent in studying the summaries he had already prepared showed concentrations of accidents in locations and activities that had received no more than casual attention—no more attention, in fact, than other locations that had perfect records. The survey study high-lighted, for instance, "lift trucks" as an agency and "operating without authority" as a related principle unsafe act. A whole train of accidental injuries had stemmed from inexpert and unauthorized driving of lift trucks. Concentrated effort applied to this problem soon restricted the operation of trucks to trained drivers and corrected an unfortunate general situation which heretofore had been treated only by nibbling at it.

There is indeed a most useful source of information in the summarization and analysis of recorded accident facts. This statement holds true even though the summarized facts are grouped under broad or general headings.

The next question is, what groups of headings should the safety engineer use to guide him most effectively in his analysis work? Unfortunately, there is no definite answer. Different kinds of information are useful in different circumstances. Sometimes "cut and try" is the most practical approach.

As one of the most useful tools of the safety director, a cross-sectioned piece of paper to be used as an analysis and summary form is recommended. This paper, with lines running horizontally and vertically, should have places for two sets of headings—on the top and at the side (see "Industrial Accident Prevention," by H. W. Heinrich, McGraw-Hill Book Company, Inc., New York, N. Y., 1941, Figs. 10, 11, 12, and 13); but it is suggested that the headings, originally, be left blank.

Two somewhat extraneous thoughts should be introduced at this time. We speak of "cause" classification, but accident causes by themselves, in the strict sense of cause definition, mean very little. It is necessary to have supplementary information, such as where people got hurt, what they got hurt on, how they were injured, and what they were doing. This in no way belittles the statistical value of the unsafe act and the unsafe condition, but suggests that additional information is necessary. All of this analysis discussion, of course, presupposes a good original accident-investigation report form and the development of accurate accident data.

It must be remembered also that "statistics" is never singular and reference is made to the facts developed from only a few accidents, where the safety director can carry all the pertinent facts in his head, without resorting to summary forms. But where there are sufficient accident data available to make analysis practical, there are a score of heading groups that can prove useful.

Before proceeding with a discussion of the proposed analysis and summary form it might be well to list a number of these group headings that can be used to advantage. They would be as follows and could include industrial, motor vehicle, home, or any other category of accidents. They are:

Agency, part of agency, unsafe condition, type of accident, unsafe act of person, specific location, type of injury, name of injured, activity, occupation, time of day, date, part of the body injured, severity of injury in time lost or dollars, etc.

The next step is the selection of those headings that will bring out concentrations of like data and this will always be a matter for local judgment. Seldom will the accident pattern be the same for two locations. An example will help to clarify this suggested procedure.

In an industrial plant a safety engineer was having difficulty in establishing a pattern of his accident occurrence. Experience was unfavorable but accidents were distributed evenly among a large number of departments. No particular agency was involved and no unsafe condition was predominant. His first clue, in using his cross-section-analysis sheet was a concentration of accidents under the type heading "falling objects." Checking these accidents against various other group headings, he found that when using "part of the body injured," a large number fell under "foot injuries."

Procedure from then on was simple. Workers, in the past, had been asked to buy safety shoes but no assistance had been offered them and no check had been made on the number so equipped. Now, however, a shoe store was set up in the plant, shoes were fitted properly and sold at cost, and in a few months foot injuries became largely nonexistent.

Through the use of a classification sheet, comparing the accident data of one group of headings with another, concentrations of accident "trouble" can be located with a minimum of desk or paper work.

Analytical summaries therefore are used for high lighting, they are signposts for pointing out areas or activities where accident-prevention work is most needed. Sometimes the necessary corrective action is immediately obvious, but in other cases the indication may be only a department or job where further study is needed.

An example might be found in a punch-press department where a concentration of accidents had been found. The summary might indicate further that accidents were happening because operators were removing guards, or making them inoperative. This information is vital to the solution of the problem but still isn't enough. Someone has to determine why operators take guards off punch presses.

There might be a single reason, such as guards not being adaptable generally to the type of production or there might be as many reasons as there are operators, including such faults as poor visibility of one set of dies, eyestrain from the reciprocating motion of a ram in the back of another guard, and fatigue from the operation of a two-handed device that was placed too high or operated too stiffly. Accident analysis may need to be supplemented by a suitable amount of job analysis.

In fact, job analysis can be considered an integral part of accident investigation. Many instances of such need can be found.

Accident prevention requires paper work. When accident data is classified properly, summarized and analyzed, it will point the way to the most prevalent accident causes and direct the work of the safety engineer to the location or activity most in need of attention, thus saving him from diffusion of his safety activities and directing him to areas most important in his accident-prevention program.

# Pneumatic Fatigue Testing

A PNEUMATICALLY operated fatigue-testing machine whose operating principle is similar to that of a slide trombone, was described by its developer, F. B. Quinlan of the Schenectady Works Laboratory of the General Electric Company, at the recent Buffalo meeting of the American Society for Testing Materials.

Originally developed to test gas-turbine buckets, it is reported that the device has proved so efficient and adaptable that it will undoubtedly have wide peacetime application.

The operating mechanism of the new instrument is extremely simple, consisting of a tuned air column in which the tuning is accomplished by decreasing the length of the air path, much as a trombone player changes the tone of his instrument by moving the slide.

The part to be tested is placed in such a position between the two air paths or tubes that the air from the open ends strike on the upper end of the sample piece, setting it to vibrating. Since the piece vibrates at the same frequency as the note in the testing trombone, and air is continually fed through the tubes, the air impulses will cause continuous vibration of the test piece. Adjusting the length of the tubes so that the air in them vibrates at the same frequency as that of the test sample makes it possible to produce very large and stable amplitudes of vibrations with comparatively small amounts of air. The sample vibrates, of course, until it fatigues to the extent that its vibrations are out of phase with those of the tuned air and a break occurs.

The pneumatic fatigue tester has produced stresses as high as 100,000 psi, with no more air being used than that supplied by the average vacuum cleaner. The tester has no parts to wear out, as nothing moves but the part to be broken. Three different models have been built, the one described, one that has proved especially efficient for torsion testing, and one for strip testing. All of them operate on the same principle, but differ in size and arrangements for holding the piece to be tested. With the exception of the strip fatigue machine, all parts may be tested at temperatures from below zero to 1700 F.

Current research with the pneumatic tester is providing preliminary data which indicate that by using a recording frequency meter, the chart will show what appears to be a point of incipient failure. This information, of course, is extremely valuable to the designer and engineer. Brittle materials show this point of incipient failure to be very close to that of complete fracture, but in ductile materials it appears long before visible fracture becomes apparent.

# Involutometry and Trigonometry

THE Michigan Tool Company, Detroit, Mich., announces the publication of a 321-page book entitled "Involutometry and Trigonometry" computed and compiled by Dr. Werner F. Vogel, associate professor of engineering, Wayne University, Detroit, which, it is said, presents for the first time new material of practical value to the gear engineer, including a rationalization of the new science of involutometry and its relation to other branches of mathematics. (Involutometry is the art of measuring and calculating involutes.)

The book classifies the various involute curves and surfaces, describes their geometrical properties, and gives the basic calculations related to them. Tables of derivatives, integrals of involutometry, and graphical characteristics are included for ready reference.

Its numerical tables are intended to simplify engineering calculations related to the design and manufacture of products based on involute curves and surfaces, such as gears, gear tools, splines, etc.

Particular attention is called to the gear appendix in the book, which contains many entirely new tables of gear formulas of value to the gear engineer.

# Carbide Mandrels

THE following hints, somewhat condensed, on proper use and care of carbide mandrels have been compiled by A. E. Glen, Carboloy Company, Incorporated, Detroit, Mich., in the interest of increasing mandrel service life; obtaining better inside finish on tubing; maintaining closer tolerances on long runs; providing more continuous operation; and decreasing rejections.

One important factor in carbide-mandrel usage is that all tubes should be so pointed that the reduced portion of the tube blends into the larger diameter with a radius rather than an angle (Fig. 16). This tends to lessen the shock on the carbide nib and makes for longer life of the equipment. All hot-pointed stock should be pickled to remove the abrasive crust of scale formed by heating. The pointed end of the tube should be open. This eliminates formation of air pockets and permits a free flow of acid and lubricant over the entire inside surface of the tube.

Proper annealing of tubes is desirable to obtain optimum economies and maximum mandrel life. The best practice is to anneal tubes, if possible, after each pass. Improper annealing will invariably result in tubes that are too hard, spotty, or otherwise below standard. Such tubes have a tendency to chatter while being drawn. Chatter eventually causes pickup and scratches on interior of the tubing and also causes excessive heating of the mandrel. Excessive heating sets up strains in the nib which in time will cause small surface cracks. These may lead to complete failure of the mandrel. Thus, mandrel life can be lengthened, costs lowered, and more continuous drawbench operation obtained by proper annealing of the tubes.

Carelessness during pickling and cleaning can cause scratches

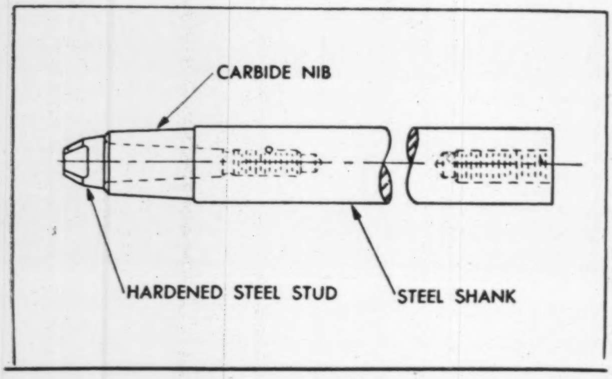


FIG. 15 COMPONENT PARTS OF A CARBOLOY MANDREL

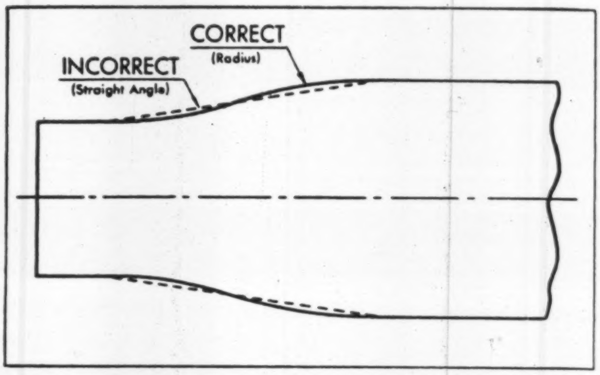


FIG. 16 POINTED END OF TUBE MUST BE OPENED TO PERMIT A FREE FLOW OF BOTH ACID AND LUBRICANT

on tubing which may put excessive pressure on the mandrel resulting in failure of the tool.

Tubes should have a light etch rather than a smooth surface on the interior. An etched surface will hold the lubricant better than a smooth surface, giving a more uniform drawing surface which reduces friction—and eliminates scratching and pickup.

Correct lubrication is extremely important. Improper lubrication results in metal-to-metal contact which creates excessive heat and causes the lubricant to break down. When that happens the carbide mandrel picks up and starts scratching the tubing. When pickup occurs the amount of heat generated is frequently enough to turn the mandrel blue. The heat may also cause surface cracks to appear on the carbide nib. Their appearance is usually followed by small particles of carbide falling from the nib and eventually by complete failure of the nib.

To lubricate, place back end of tube in lubricant tank first. Gradually submerge the entire tube. If done correctly, this expels all air and permits complete coverage of lubricant over interior surface of tube.

Correct draw bench alignment is important in obtaining optimum benefits from carbide mandrels as well as other types. The die should be lined up accurately with the grip-and-pull carriage in order to draw the tube on-size and straight. Improper alignment produces bowed and off-size tubing.

When setting up a carbide mandrel, it is important that the mandrel be set in the correct position in relation to the die. Slightly different practices are required for tapered and straight mandrels.

A tapered mandrel should be set just far enough into the die to produce the correct size, Fig. 17. The setup should be checked to make sure that the tubing does not start to reduce on the steel shank in back of the carbide unit. If this occurs, wear marks will show after drawing. Experience to date shows that tapered mandrels are more efficient than straight ones. Ample clearance of the mandrel's point is automatically provided by the taper after the inside diameter of the tubing has been sized. Area of contact is also reduced with tapered mandrels. This helps maintain efficient lubrication.

The straight mandrel should be set into the die so that the end of the mandrel's chamfer extends slightly past the bearing, Fig. 18. If a straight mandrel is extended too far through the die, too much of the mandrel's surface will be in contact with the tube's interior. This condition may cause pickup due to unnecessary friction and strains on the mandrel. However, if the mandrel is not set far enough into the tube, it is virtually impossible to get the tube to start.

Tubing should always be trimmed regularly to lengthen the life of the mandrel. After a tube has been drawn through several passes, the elongations will cause a "scalloped" back end to form on it, thus setting up considerable stress when such a tube is drawn over the mandrel.

Greater efficiency is obtained from mandrels by servicing at predetermined and regular intervals. Regular servicing gives better tubing; reduces operating costs; and results in longer over-all mandrel life.

After considerable use, slight "rings" and wear marks will develop on the carbide nib of the mandrel at the point where tube reduction starts. If serviced as soon as these wear rings appear, the rings can easily be removed by lapping and polishing.

If prompt servicing is neglected, deep wear rings will even-

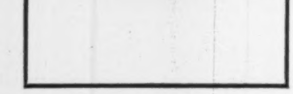


FIG. 17 SET TAPERED MANDREL INTO DIE FOR CORRECT SIZE

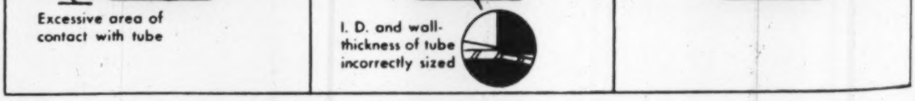

—WRONG—
Mandrel placed too far into die
Bearing
Excessive area of contact with tube
—WRONG—
Mandrel not inserted far enough into die
Bearing
I. D. and wall-thickness of tube incorrectly sized
—RIGHT—
Front of mandrel nib extends just slightly past bearing of die
Bearing

FIG. 18 SET STRAIGHT MANDREL INTO DIE SO THAT END OF CHAMFER EXTENDS JUST SLIGHTLY PAST THE BEARING

tually form in the nib. Such rings tend to remove all lubricant from the tubing.

A straight type mandrel which has worn undersize may be salvaged by resetting the mandrel further into the die. Before doing so, however, it is important that a recess be ground into the mandrel nib so as to avoid too great an area of contact with the tube.

When drawing steel tubing, a sharp-edged chamfer should be maintained on the mandrel nib's front end. If this chamfer becomes rounded over, the mandrel will not immediately bite into the tubing. If this happens, no reduction of tubing wall thickness occurs for some 6 to 8 in. during the first draw. This means that the mandrel must take a double reduction at the start of the next drawing operation. The sudden jerk that occurs when point of normal reduction is reached tends to put excessive strain on the carbide mandrel.

In case of a double reduction, the tube end should be cut off beyond the area of double reduction and then repointed. A sharp chamfer may be maintained on the mandrel nib's front end by grinding it with a 100-grit diamond wheel, or by turning it with a diamond boring tool in a lathe.

These simple precautions will greatly increase the effectiveness of carbide mandrels in tube mills. Neglecting these factors may result in sacrificing a considerable portion of the better inside finish on tubing; closer tolerances on long runs; higher drawing speeds; increased footage per day; and longer mandrel life; all of which are possible by the correct use and servicing of carbide mandrels and dies.

# Thermistor-Controlled Devices

THERMISTOR-CONTROLLED devices that can scan a darkened landscape and immediately record the presence of some infinitestimally warmer object—such as a man—when it comes into their line of sight, have been developed by the Bell Telephone Laboratories. So fine is their perception that from high altitudes they can indicate the pattern of rivers by the difference in heat radiation between land and water. Not only can they detect a ship against its watery background, but they can even distinguish the warmer parts, such as the stacks, from the rest of the ship.

Developed originally for use in the telephone network and mass-produced by Western Electric Company, thermistors (a contraction of thermal resistors) not only enabled wartime magic but in peace promise to increase the precision of temperature measurements tenfold.

Standard precision thermometers which use the resistance of a platinum wire as a temperature scale are accurate only to one hundredth of a degree. With apparatus no more elaborate, however, it is claimed that thermistors can gage variations of five ten-thousandths of a degree.

Bell Laboratories designed several equipments which could detect the lesser heat radiated by such nonincandescent objects as men, vehicles, ships, and factory chimneys. These were successfully tested before the war ended.

The basic principle was the same in all of them. Since heat rays behave in much the same way as light rays, they were collected in a parabolic reflector which could be pointed at specific objects in the same manner as the reflector of an astronomical telescope. This reflection focused the "black light" radiation of the object on the tiny thermistor element which was connected with an amplifier to signal any change in the heat it received.

Thermistors have a wide variety of uses in and out of telephony. They can be balanced with resistors in voltage regulators to supply a constant output from a varying source or under varying temperature conditions. They were used extensively during the war to supply a standard for measuring the power output of radar sets.

An example of their versatility is their use as time-delay elements. It takes time for them to heat up enough to pass the large and sudden surges of current sometimes fed to them. By varying the design of the particular thermistor and the circuit application, the time-delay may be set anywhere from one ten-thousandth of a second to more than ten minutes.

# The Army's Research Program

(*Continued from page 786*)

I am taking advantage of every opportunity afforded me to bring the civilian and the military closer together. I am thankful for this opportunity to meet with you and tell you something about our research and development plans for the future.

As the late President Roosevelt said, "New frontiers of the mind are before us," and they must be pioneered with the same vision, boldness, and drive with which we have waged war.

The Army is fully alert to the fact that success in war will not be possible unless the Armed Forces have the best weapons that the scientific and industrial talent of the country can bring forward. We are firmly committed to the policy that future planning must involve the concept of a steady partnership of the military, science, and industry.

Many of you have engaged in important research and development work for the War Department in the past and many of you will undertake such assignments in the future. It is important that you know that my office is most anxious to profit from your advice and suggestions. It needs your assistance in connection with its work on military research and development problems. Many of you have worked with the Army's operating agencies—the Air Forces, the Ground Forces, and the several Technical Services. These have been and will continue to be your most frequent contacts with the Army. But I hope that you will also feel free to turn to the Research and Development Division whenever you are uncertain as to which operating agency would be able to profit most from your efforts in military research and development work.

What has been said here is a reiteration of the old concept that in the United States of America the Armed Forces are what the people want them to be. They belong to the people and are as ready and strong as the support given to them by the people. In the field of science and engineering, the same is true. No effort by the military will produce results without the support of the scientists and engineers of the country. The support required is not solely a question of adequate appropriations. It is the question of the enlistment of scientists and engineers like yourselves in the personal support of the research and development activities of the Army. Even if your interest is sufficient only to decry from time to time what we are doing, the limitless task ahead becomes less because you are thinking about it. If the Army's program is short of sufficient, or fails to reach its goal, it will probably be because you did not demand and support proper action. If it succeeds, yours is the credit. Like the Army itself, its research and development organization belongs to you.

Our common goal for the future is to organize a research and engineering team of civilian and military personnel whose material and social accomplishments will guarantee to our country the security and freedom from fear so necessary to the future existence of the American way of life.

# A.S.M.E. BOILER CODE

## Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of June 21, 1946, and approved by the Council on July 31, 1946.

### Case No. 1028

*(Special Ruling)*

*Inquiry:* Since the current studies on the subject of graphitization in high-temperature piping have listed "stress" as one of the possible contributing factors, may the required stamping on equipment operating at high temperatures be applied to a nameplate instead of on the piping itself as required in Pars. P-300 and P-332(**e**)?

*Reply:* It is the opinion of the Committee that the intent of the Code will be met if, on equipment operating at temperatures above 800 F, the stamping required by Pars. P-300 and P-332(**e**) is applied to a nameplate which is irremovably attached by welding to the part, provided such welding is stress-relieved, or on a circular metal band at least $^{1}/_{4}$ in. thick slipped over the end of the pipe.

### Case No. 1029

*(Interpretation of Par. A-18(a))*

*Inquiry:* Par. A-18(**a**) requires that in automatic shutoff valves on water gages the check valves in upper and lower fittings must be of the solid nonferrous ball type. Is it permissible to use stainless steel balls as an optional material for this service?

*Reply:* It is the opinion of the Committee that the use of check valves of the solid ball type of noncorrosive metal will meet the intent of the Code.

### Case No. 1030

*(Special Ruling)*

*Inquiry:* Is it permissible under the rules of Section VIII of the Code to use centrifugal castings of 29 per cent chromium and 9 per cent nickel alloy steel for the main shell and nozzles of welded unfired pressure vessels?

*Reply:* It is the opinion of the Committee that centrifugal castings of this composition will meet the intent of the Code for such purposes provided the following additional requirements are met:

(1) The material shall comply with the chemical and physical requirements of A.S.T.M. Specifications A 222-39, Class C, except that the tensile elongation shall be not less than 15 per cent;

(2) The finished vessels shall be heat-treated by heating to 2000 F and water quenched;

(3) The allowable working stress shall not exceed 10 per cent of the specified minimum tensile strength;

(4) The operating temperature shall be not less than 70 F nor more than 650 F;

(5) The wall thickness as cast shall be not less than $^{1}/_{2}$ in.

## Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published herewith with corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N.Y., in order that they may be presented to the Committee for consideration.

PARS. P-102(**b**), L-102(**b**). Revise third section to read:

When there are several pressure parts being welded in succession on any one order, the plate thicknesses of which fall within a range of $^{1}/_{4}$ in., with diameters differing not more than 6 in., and of the same grade of material, a test plate shall be furnished for each 200 [50 linear] feet, or fraction thereof, of the main welded joints.

PAR. P-243. Add the following:

When the longitudinal joint has been completely radiographically examined, the individual bend test for each furnace is not required.

PAR. P-296. Revise fourth, fifth, and sixth sentences of first section to read:

Steam gage connections which are filled with water or steam shall be suitable for the maximum allowable working pressure and steam temperature but if the temperature exceeds 406 F, brass or copper pipe, or tubing shall not be used. The connections to the boiler, except the syphon, shall not be less than $^{1}/_{4}$ in. standard pipe size but where steel, or wrought-iron pipe or tubing is used, they shall not be less than $^{1}/_{2}$ in. inside diameter. That portion of the connection used as a syphon next to the steam gage shall not be less than $^{1}/_{4}$ in. inside diameter.

PAR. P-299(**b**). Revise first section to read:

(**b**) The thickness of all fittings or valve bodies subject to pressure shall be not less than that required by the American Standard for the corresponding maximum allowable working pressure and temperature for the material used, except that in order to provide equal thicknesses for welding, the cylindrical ends of cast steel welding-end valves and fittings may be proportioned with a quality factor of 100 per cent, provided these areas are finish-machined both inside and outside and are carefully inspected. In no case, however, shall the thickness of [the] WELDING ends be less, nor more than 15 per cent greater than [that] THE NOMINAL WALL THICKNESS of the adjoining pipe. The machined ends OF VALVE OR FITTING BODIES [may] SHALL be extended back in any manner, WITH THE PRINCIPAL TAPER EITHER INSIDE OR OUTSIDE WITH REFERENCE TO THE PIPE WALL, provided the [longitudinal-section] TOTAL TAPER comes within the maximum slope line indicated in Fig. P-40. The transition from the pipe to the fitting OR VALVE at the joint shall be of a shape avoiding sharp re-entrant angles and abrupt changes in slope.

PAR. A-18 (a). Revise to read:

(a) Check valves in upper and lower fittings SHALL [must] be of the solid [nonferrous] ball type, OF NONCORROSIVE METAL to avoid [corrosion and the necessity] NEED for guides.

TABLES P-7 and U-2. For Specification SA-240, Grade M, increase working stress from 5000 to 5300 at 1150 F, and increase working stress from 3600 to 4000 at 1200 F.

TABLES P-7 and U-2. Add the following values for the materials indicated:

| Temperature, deg F | SA-213, Grade T8<br>SA-249, Grade T8<br>SA-240, Grade S | SA-213, Grade T19<br>SA-249, Grade T19<br>SA-240, Grade C | SA-213, Grade T18<br>SA-249, Grade T18<br>SA-240, Grade T | SA-213, Grade T20<br>SA-240, Grade M<br>SA-249, Grade T20<br>SA-249, Grade T24 |
|---|---|---|---|---|
| 1250 | 2600 | 2600 | 2600 | 3100 |
| 1300 | 1950 | 1950 | 1950 | 2350 |
| 1350 | 1450 | 1450 | 1450 | 1800 |
| 1400 | 1100 | 1100 | 1100 | 1350 |
| 1450 | 800 | 800 | .. | 1050 |
| 1500 | 600 | 600 | .. | 800 |

---

# Books Received in Library

AIRCRAFT PRODUCTION DESIGN. By J. E. Thompson. Aviation Press, San Carlos, Calif., 1945. Stiff paper, ring binder, $7\frac{1}{2} \times 9\frac{1}{4}$ in., 238 pp., plus index, illus., diagrams, charts, tables, $5. Design procedure is considered with respect to production methods, the serviceability and accessibility of parts, machineability, and the factors of repair and lubrication. The various operations which enter into the manufacture of airplane parts are described with discussion of their adaptations and limitations. Separate chapters are devoted to materials for airplane construction and to standardized parts.

GAS IN LIGHT ALLOYS. By L. W. Eastwood. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1946. Cloth, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 99 pp., illus., diagrams, charts, tables, $2.50. Comprehensive, simple, and practical, this book tells how gas is absorbed in light alloys and how the quantity of the gas absorbed can be measured. It gives the identity of the gas involved, the method by which it may be removed, a description of the type of defects caused by the gas, its effects upon the properties of the metal and other important data. There is a bibliography.

HEATING AND VENTILATING OF DWELLINGS (Postwar Building Studies No. 19). By the Heating and Ventilation (Reconstruction) Committee of the Building Research Board of the Department of Scientific & Industrial Research, published for the Ministry of Works by His Majesty's Stationary Office, London, England, 1945. Paper, $6 \times 9\frac{1}{2}$ in., 228 pp., diagrams, maps, tables, 2s 6d. (British Information Services, New York, N. Y., $0.80). The major purposes of this report are as follows: To determine the average conditions of warmth and ventilation which are desirable, and the minimum provision for hot-water supply and cooking; to find the amount of heat theoretically needed in an average house to provide these basic facilities and show how this amount is affected by the construction of the house, etc., and to discuss the various factors relating to the choice of methods of heating. Special topics dealt with separately are: ventilation methods; clothes washing; the development, installation, and operation of heating appliances; testing and standardization of appliances; and the use and distribution of fuel.

HEATING OF STEEL. By M. H. Mawhinney. Reinhold Publishing Corporation, New York, N. Y., 1945. Cloth, $6 \times 9\frac{1}{4}$ in., 265 pp., illus., diagrams, charts, tables, $4.75. The opening chapter discusses the oxidation, carburization, and decarburization of steel when heated under various conditions. The succeeding six chapters deal with purposes for which steel is heated, and practical information concerning the heating methods, types of furnaces, and furnace tools which are important in obtaining the best results. Refractories and the relation between heat transfer and fuel economy are also covered.

HEATING, VENTILATING, AIR CONDITIONING GUIDE, 1946, Technical Data Section, Manufacturers' Catalog Data Section, Roll of Membership and Complete Indexes. Vol. 24. American Society of Heating and Ventilating Engineers, New York, N. Y., 1946. Fabrikoid, $6 \times 9\frac{1}{4}$ in., 1279 pp., plus 94 pp., illus., diagrams, charts, $6. This standard manual constitutes both a textbook and handbook on the design and specification of heating, ventilating, and air-conditioning systems. The technical section has been thoroughly revised, and much new material has been added, including a chapter on fluid flow. It provides all the data ordinarily needed by engineers and architects, cross-indexed for quick reference. The catalog section contains information on the products of over two hundred manufacturers, with a classified index.

HISTORY OF KIRKSTALL FORGE THROUGH SEVEN CENTURIES, 1200–1945 A.D. Kirkstall Forge Ltd., Leeds, England, 1945. Paper, $10 \times 12$ in., 152 pp., illus., diagrams, tables, 25s plus 3s 9d postage. Kirkstall Forge, established by the monks of Kirkstall Abbey about the year 1200, has been in active production for some seven centuries. The author, whose forebears came into control in the late 18th century, presents the available historical facts of the early years and chronicles the development and expansion of the works to the present date. Reproductions of early documents, photographs, and plans of the works, with reports and correspondence on its operation, add to the picture of the notable concern.

IL CALCOLO DELLE VIBRAZIONI TORSIONALI NEI MOTORI A COMBUSTIONE INTERNA con speciale riguardo ai motori per impianti navali. By G. Rossi. Collana Tecnica "Grandi Motori," 1944. Linen, $6\frac{1}{2} \times 9\frac{1}{2}$ in., 255 pp., illus., diagrams, charts, tables. This book presents an analysis of torsional vibration in the internal-combustion engine with all calculations involved. Special regard is paid to marine-engine installations and a practical example is included. A separate chapter is devoted to the subject of damping. A large section of tables, charts, and illustrative diagrams follows the text material.

INDUCTION HEATING. By H. B. Osborn and others. American Society for Metals, Cleveland, Ohio, 1946. Cloth, $6 \times 9\frac{1}{4}$ in., 172 pp., illus., diagrams, charts, tables, $3. Five lectures presented at the 1946 National Metal Congress are combined in this book. They deal respectively with: the principles and theory of high-frequency heating; induction-heating circuits and frequency generation; practical applications of the motor generator type of induction heating (up to 10,000 cycles); practical applications of high-frequency induction heating (100,000 cycles and up); and a comparison of induction heating with other methods of heat-treating.

INDUSTRIAL ECONOMY AND LABOR CONTROL. By W. L. McNaughton. Golden State Publishers, Los Angeles, Calif., 1945. Cloth and paper, $5\frac{1}{4} \times 8$ in., 273 pp., illus., diagrams, charts, tables, cloth, $3.25; paper, $2.75. Dealing chiefly with motion and time study, this book devotes the first two sections to discussion of the importance and purpose of their application in an industrial plant. The succeeding three sections take up the practical aspects of plant layout, time study, and motion economy, including materials-handling and tool-positioning. The questions of management's acceptance and of employee co-operation are also considered.

INDUSTRIAL RELATIONS AND THE SOCIAL ORDER. By W. E. Moore. The Macmillan Company, New York, N. Y., 1946. Cloth, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 555 pp., charts, tables, $4. Intended to supplement the "standard" treatments of industrial organization and relations, this book emphasizes the viewpoint of modern industry as a complex social organization. Following a discussion of the development of modern industry, come sections dealing with management and managerial functions, the sources and effective use of labor, and industrial relations. The final part discusses the interrelation of industry and society in general, including economic planning.

PRACTICAL OPTICS. By B. K. Johnson. Hatton Press, Ltd., London, E.C.4, England, 1945. Cloth, $5\frac{1}{2} \times 9$ in., 189 pp., illus., diagrams, tables, 15s. This small volume presents the practical application of optical principles. These principles are discussed in the first two chapters, with succeeding chapters dealing respectively with the three main types of optical instruments: telescopes, microscopes, and photographic lenses. A chapter is devoted to the working and testing of optical glass.

## *Library Services*

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

# A.S.M.E. NEWS

*And Notes on Other Engineering Societies*

## A.S.M.E. 1946 Fall Meeting to Be Held at Hotel Statler, Boston, Mass., Sept. 30 to Oct. 3, 1946

### Society Honors R. E. Flanders and I. E. Moultrop

YANKEE ingenuity and traditional New England hospitality are reflected in the program planned for the 1946 Fall Meeting of The American Society of Mechanical Engineers which is to be held at the Hotel Statler, Boston, Mass., Sept. 30 to Oct. 3, 1946. Not only does the program present technical papers of local and national significance, but opens up to members and guests some of the opportunities and experiences that have made Boston one of the industrial and cultural centers of the nation.

The meeting will be set in the full color of the New England Indian Summer when the weather is bright and invigorating. More than five plants will open their doors to show visitors the character and variety of New England industries. Two of the plants will be hosts to visitors at luncheons in their plant cafeterias before escorting them through the shops. In many restaurants of the historic seaport city, lobster and cod and oysters and clams, fresh from the Atlantic and prepared in the traditional New England manner, will be sure to create a savory delight that will be remembered long after the meeting.

### Technical Sessions

Twenty-one technical sessions are planned by the following divisions and groups: Aviation, Education and Training, Fuels, Heat Transfer, Hydraulic, Machine Design, Management, Metals Engineering, Power, Production Engineering, Textiles, and Wood Industries.

### Plant Trips

The program has been planned so that at least two afternoons will be free of technical sessions in order that members may enjoy fully the various plant-inspection trips planned for them.

There are two trips on Monday afternoon. The first is to the Quincy Market Cold Storage and Warehouse Company, one of the oldest and largest of its kind in the world. This plant produces refrigeration for an extensive underground pipe line which feeds about seven hundred customers throughout the Boston market area. The second trip is to the experiment station of E. B. Gadger and Sons Company, Fosters Wharf, Boston, Mass., where visitors will see a Kleinschmidt compression evaporator in operation producing high-purity distilled water from Boston harbor water.

On Tuesday morning, Oct. 1, a bus will leave the hotel for the Maverick Mills, East Boston, Mass., on a visit to one of the progressive New England textile mills where voiles, lawns, dimities, all combed gray goods, and fine yarns are manufactured.

In the afternoon of the same day the General Electric Company, Lynn, Mass., will be host to A.S.M.E. visitors at a luncheon in the plant cafeteria following which the visitors will inspect the various shops and foundries of the plant.

A tour of Harvard University has also been arranged for Tuesday afternoon.

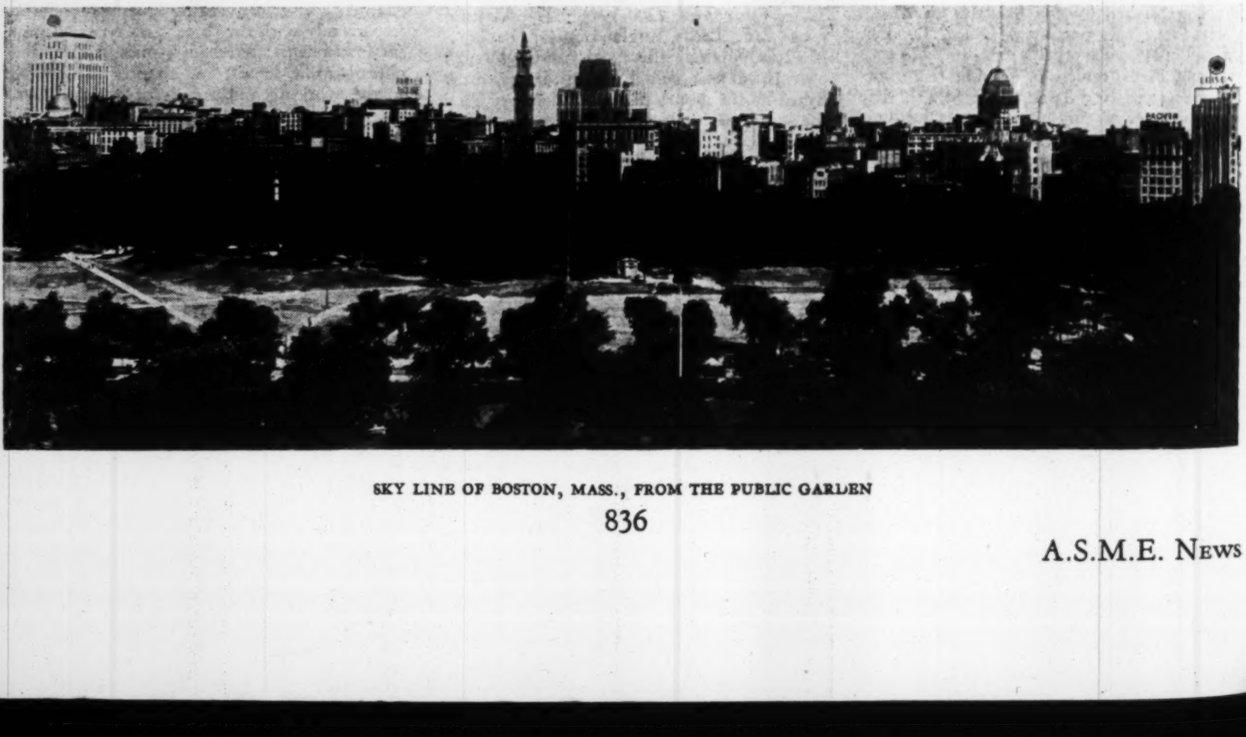
On Wednesday, Oct. 2, B. F. Sturtevant Company, Division of Westinghouse Electric Corporation, Hyde Park, Mass., will be host to visitors at a luncheon in the plant cafeteria. The visitors will be shown the manufacture of fans, blowers, compressors, and other air-handling and air-conditioning equipment.

At the Massachusetts Institute of Technology, Cambridge, Mass., a tour has been arranged for A.S.M.E. visitors through the Center of Analysis, which houses the "Differential Analyzer," the Wright Wind Tunnel, and other laboratories of interest.

On Thursday afternoon, Oct. 3, another party will leave by bus for the Mystic Station of the Boston Edison Company where they will see one of the most recent 1200-lb 900-F steam-power stations.

### Banquet

Two eminent fellows of The American Society of Mechanical Engineers will be honored at the banquet, Wednesday, Oct. 2, when certificates of honorary membership will be presented to Ralph E. Flanders, past-president, A.S.M.E., formerly president, Federal Reserve Bank of Boston, and president (on leave), Jones



SKY LINE OF BOSTON, MASS., FROM THE PUBLIC GARDEN and Lamson Company, Springfield, Vt., and to Irving E. Moultrop, past vice-president, A.S.M.E., consulting engineer, Belmont, Mass.

### Ralph E. Flanders

Mr. Flanders, a dominant figure in the economic life of New England has had a long period of service in the A.S.M.E. He was manager of the Society from 1926 to 1929, vice-president in 1930 and 1931, and president in 1935. Although a machine designer and mechanical engineer of international standing, his wide experience in problems of the relations of labor to capital and capital to government, have taken him into the field of public service, where he has won wide recognition.

### Irving E. Moultrop

Mr. Moultrop, past manager (1908 to 1911) and past vice-president (1912 to 1914), A.S.M.E., has been intimately connected with the growth and development of the electric utility industry in America since the turn of the century. He has served on the prime-mover committee of the National Electric Light Association and various committees of the A.S.M.E. and A.I.E.E. As chief engineer for The Boston Edison Company, he designed and installed many electric power stations. His work included design of mechanical and electric equipment as well as underground construction for electric transmission.

### Historic Boston

In addition to the technical attractions of the 1946 Fall Meeting, the program includes several tours through historic Boston. Of the landmarks of colonial Boston, the earliest is the Fairbanks House (1636) in Dedham, Mass. The record of the settlers can be followed in buildings and monuments. Salem witchcraft, the Boston Tea Party, Bunker Hill, the birthplace of Benjamin Franklin, George Washington's headquarters during the siege of Boston, Emerson's home, Longfellow's Wayside Inn are among the suggested tours. A visit to the Old North Church, Concord, and Lexington will recall in detail the story of Paul Revere.

### Women's Program

A delightful women's program has been arranged for wives of members and guests attending the meeting. On Monday afternoon there will be a complimentary tea, followed in the evening by informal bridge at Hotel Statler.

On Tuesday, a tour has been planned that will take the women to Concord and Lexington. This will include a visit to the Louisa May Alcott House and the Battle Grounds. A luncheon at Longfellow's Wayside Inn will follow and the party will return through Waltham, Mass., stopping at the Gore Mansion.

On Wednesday, the program calls for a trip to Salem, Mass., stopping at The House of Seven Gables. For luncheon the party will go to the General Glover Inn, Marblehead, Mass., and later will visit the King Hooper House. In the evening there will be the banquet at Hotel Statler.

RALPH E. FLANDERS, HONORARY MEMBER A.S.M.E.

### Committee

The general committee for the 1946 Fall Meeting of the A.S.M.E. Boston Section consists of the following: Chairman, H. M. King; secretary, C. B. Seelig; technical events, chairman, Kerr Atkinson, vice-chairman, C. R. Soderberg; printing and signs, chairman, E. L. Root, vice-chairman, R. L. Williams; hotels, chairman, Fred Farrell; entertainment, chairman, W. F. Ryan, vice-chairman, H. S. Houghton; plant trips, chairman, G. K. Saurwein, vice-chairman, F. M. Carhart; information and registration, chairman, S. S. Perry, vice-chairman, E. K. Bancroft; publicity, chairman, G. A. Orrok, Jr., vice-chairman, H. L. Von Rehberg; reception, chairman, I. E. Moultrop; ladies' program, chairman, Mrs. C. Harold Berry; finance, chairman, R. D. Stauffer, vice-chairman, H. W. Dawes; and students, chairman, Holcombe Brown.

## Tentative Program

The tentative program follows:

### MONDAY, SEPT. 30

**8:00 a.m. to 8:00 p.m.**

**Registration**

**9:00 a.m.**

**Historic Trips about Boston**

**12:15 p.m.**

**General Luncheon**

*Georgian Room*

*Toastmaster:* H. M. King, assistant engineer, steam-turbine engineering division, General Electric Company, Lynn, Mass., chairman, A.S.M.E. 1946 Fall Meeting Committee

*Speakers:*

Honorable Morris J. Tobin, Governor of Massachusetts, "Greetings From the Commonwealth."

D. Robert Yarnall, President, A.S.M.E., response and greetings to the Society.

F. S. Blackall, Jr., president, New England Council and The Taft-Peirce Manufacturing Company, Woonsocket, R. I.

**2:00 p.m.**

**Plant-Inspection Trips**

*Trip 1.* Visit to the Quincy Market Cold Storage and Warehouse Company, 69 Eastern Avenue, Boston, Mass., where visitors will see one of the largest warehouses of its kind in the world.

*Trip 2.* Visit to the experiment station of E. B. Badger and Sons Company, Fosters Wharf, Atlantic Avenue, Boston, Mass., where visitors will see the Kleinschmidt compression evaporator which produces high-purity distilled water from Boston harbor water.

**2:30 p.m.**

**Heat Transfer (I) Session**

"Temperature Distribution in a Hollow Cylinder Heated by a Point Source Moving Along Its Axis," D. Rosenthal, professor, department of metallurgy, Massachusetts Institute of Technology, Cambridge, Mass.

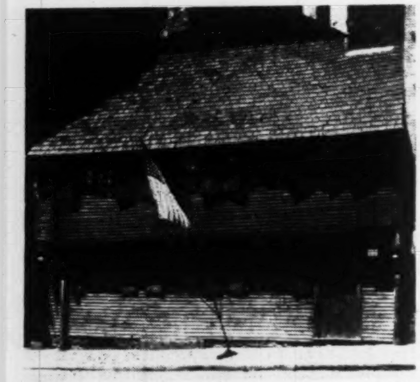
"Thermal Properties of Laminated Materials and Their Significance for Uniform Heating," by V. Paschkis, research associate in charge of heat and mass flow analyzer laboratory, Columbia University, New York, N. Y., and Joseph L. Finck, J. L. Finck Laboratories, Brooklyn, N. Y.

**Management (I) Session**

"Principles of Organization," by Edgar W. Smith, vice-president, General Motors Overseas Operations, New York, N. Y.

"Organization Requirements for Successful Export Business," by George Wolf, president,

IRVING E. MOULTROP, HONORARY MEMBER A.S.M.E.



THE PAUL REVERE HOUSE IN BOSTON, MASS.

U. S. Steel Export Company, New York, N. Y.

### Hydraulic (I) Session

"The Shock Produced by a Collapsing Cavity in Water," by M. F. M. Osborne, physicist, vibration section, sound division, Naval Research Laboratory, Washington, D. C.

"Investigation of Flow in Liquids by the Use of Birefringent Colloidal Solutions of Vanadium Pentoxide," by Philip Ullyott, professor of biology, Robert College, Istanbul, Turkey.

**6:15P.M.**

### Dinner

*Georgian Room*

*Toastmaster:* C. W. MacGregor, professor of applied mechanics, Massachusetts Institute of Technology, Cambridge, Mass.

*Speaker:* Albert Haertlein, president Engineering Societies of New England. Subject: "Co-Operation of Engineering Society in the Boston Area."

**8:00 p.m.**

### Fuels (I) Session

"Twenty Years of Progress in Industrial Oil Firing," by Rene J. Bender, assistant to chief consulting engineer, Sinclair Refining Company, New York, N. Y.

"The Packaged Boiler," by Martin Frisch, director, engineering and development, and H. H. Hemenway, assistant to director of engineering, both of Foster Wheeler Corporation, New York, N. Y.

### Management (II) Session

"Engineers and Industrial Relations," by Charles A. Myers, associate professor of industrial relations, Massachusetts Institute of Technology, Cambridge, Mass., and Clifton Lovenberg, assistant manager American Octanator Corporation, Pawtucket, R. I.

### Wood Industries (I) Session

"Emergency Housing," by Walter C. Voss, professor, department of building engineering and construction, Massachusetts Institute of Technology, Cambridge, Mass.

"The Application of Wood and Fiber to Industrial Packing," by Joseph A. DeLuca, division superintendent, engineering department, E. I. du Pont de Nemours Co., Inc., Wilmington, Del.

"Plywood in Boat Construction," by Francis W. Hagerty, president, F. W. Hagerty and Co., Inc., Cohasset, Mass.

### Hydraulic (II)

"New Hydro Plants for Old Ones," by Frank H. Mason, chief engineer, Nepsco Services, Augusta, Me.

"Replacement and Modernization of Original Hydraulic Turbines at Vernon Plant of the Connecticut River Power Company," by G. F. Crowe, hydraulic engineer, New England Power Service, Boston, Mass.

## TUESDAY, OCT. 1

**9:00 a.m.**

### Wood Industries (II) Session

"Uses of Lignin in Agriculture," by Stuart Dunn, associate professor of botany and plant physiologist, and Joseph Seiberlich, research assistant professor of industrial engineering, both of New Hampshire Agricultural Experiment Station, University of New Hampshire, Durham, N. H.

"Molded Plastic Products," by Robert A. Caughey, director of research, Souhegan Mills, Wilton, N. H.

"Problems in the Utilization of Wood Waste," by Robert S. Aries, director, North Eastern Wood Utilization Council, New Haven, Conn.

### Management (III) Session

"Collective Bargaining at the Crossroads," by Philip Taft, professor of economics, Brown University, Providence, R. I., and Martin B. Horan, employee relations manager, Owens-Corning Fiberglas Corporation, Ashton, R. I.

### Fuels (II) Session

Panel Discussion on "Single Retort Underfeed Stokers," by Ollison Craig, engineering manager, Riley Stoker Corporation, Worcester, Mass. Other participants will be announced later.

Motion picture on "Pulverized-Coal Furnaces," by Otto de Lorenzi, director of education, Combustion Engineering Co., Inc., New York, N. Y.

### Production Engineering (I) Session

"Part Tolerances From Assembly Tolerances," by L. C. Young, quality-control engineer, Westinghouse Electric Corporation.

**9:45 a.m.**

### Plant-Inspection Trip

Visit to Maverick Mills, 144 Addison Avenue, East Boston, Mass., a textile mill manufacturing voiles, lawns, dimities, all combed gray goods, and fine yarns.

**12:30 p.m.**

### Wood Industries Luncheon

*Hancock Room*

Motion picture "Conveyerized Box Making" by A. B. Atwood, Atwood and McManes, Chelsea, Mass.

**12:30 p.m.**

### Plant Inspection Trip

Visit to the General Electric Company, Riverworks, Lynn, Mass., where visitors will be guests of the Company at luncheon in plant cafeteria and later escorted through the various shops of the plant.

**1:00 p.m.**

### Textile Luncheon

*Georgian Room*

*Speaker:* Austin S. Kibbee, technical adviser, Manawul Manufacturing Company, Boston, Mass. Subject: "Ramie and Its Products."

**2:00 p.m.**

### Inspection Trip

Visit to Harvard University, Cambridge, the oldest institution of higher learning in America, where visitors will see the Computation Laboratory housing the automatic sequence calculator, the Houghton Rare Book Library, and various museums.

**2:30 p.m.**

### Textile (I) Session

"Materials Designed to Augment or Replace Woven and Knitted Fabrics," by Simon Williams, research engineer, Fabrics Research Laboratories, Inc., Boston, Mass., and Albert Dietz, professor, Massachusetts Institute of Technology, Cambridge, Mass.

**5:30 p.m.**

### Informal Meeting Textile Division

*Exhibition:* A fully automatic bobbin changing loom.

**6:15 p.m.**

### Dinner

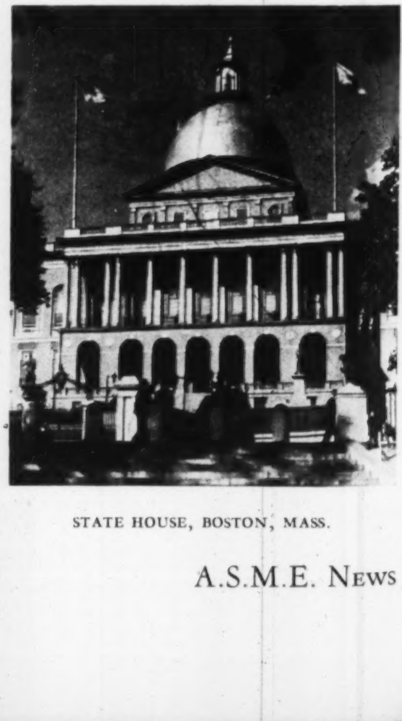
*Toastmaster:* W. C. White, dean, Northeastern University, Boston, Mass.

*Speaker:* Eugene W. O'Brien, nominee for President, A.S.M.E., 1946–1947, vice-president, W. R. C. Smith Publication Company, Atlanta, Ga. Subject: "Places to Go and Things to Do."

**6:45 p.m.**

### Textile Dinner

*Speaker:* M. N. Mitchell, president and man-



STATE HOUSE, BOSTON, MASS.

ager, Barnes Textile Association, Boston, Mass. Subject: "Textile College Undergraduate Education."

**8:00 p.m.**

### Aviation (I) Session

"Characteristics of Turbo-Jet Engines at High Flight Speeds," by Charles A. Meyer, thermodynamics section engineer, Westinghouse Electric Corporation, Lester, Pa.

"A Proposed Method for Measuring Fluctuating Flame Temperatures," by Captain Willard A. Knapp and Major George A. Wood, Power Plant Laboratory, Air Materiél Command, Wright Field, Dayton, Ohio.

### Education and Training (I) Session

"An Immediate Measure to Strengthen the Professional and Economic Position of the Engineering Profession," by C. W. Ransom, General Electric Company, Pittsfield, Mass.

"Collective Bargaining for Professional Personnel," by Raymond L. Forshay, market analyst for power department, Tennessee Valley Authority, Knoxville, Tenn.

### Metals Engineering (I) Session

"Role of Castings in Engineering Production," by C. R. Austin, Meehanite Metals Corporation, New Rochelle, N. Y.

## WEDNESDAY, OCT. 2

**9:00 a.m.**

### Aviatioh (II) Session

"Seat Comfort," by Francis E. Randall, consultant, Office of the Quartermaster General, Washington, D. C.

"Psychological Factors Affecting Safety in the Design and Operation of Aircraft," by Paul M. Fitts, chief, psychology branch, Aero Medical Laboratory, engineering division, Wright Field, Dayton, Ohio.

### Metals Engineering (II) Session

"Permanent-Magnet Materials," by J. H. Goss, General Electric Company, West Lynn, Mass.

"Failure of Steam-Hammer Piston Rods," by George Cherniak, engineer, J. M. Lessells and associates, Boston, Mass.

### Machine Design (I) Session

"Some Consideration in Designing Parts for Powder Metallurgy," by Irving J. Donahue, Presmet Corporation, Worcester, Mass.

"Variable-Feed Control Mechanism," by Earle C. Miller, design engineer, Riley Stoker Corporation, Worcester, Mass.

**12:15 p.m.**

### General Luncheon

*Georgian Room*

*Toastmaster:* Alton C. Chick, vice-president A.S.M.E. Region I, assistant vice-president, Manufacturers Mutual Fire Insurance Company, Providence, R. I.

*Speaker:* M. L. Deyo, rear admiral, U. S. Navy, commandant, First Naval District. Subject: "War and Postwar Industry in New England From Naval Standpoint."

THE HISTORIC U.S.S. CONSTITUTION IN BOSTON, MASS.

**12:30 p.m.**

### Inspection Trips

Visit to B. F. Sturtevant Company, Division of Westinghouse Electric Corporation, where visitors will be guests of the Company at luncheon in plant cafeteria before being escorted through the shops.

**2:00 p.m.**

Visit to Massachusetts Institute of Technology where visitors will see Center of Analysis Differential Analyzer, the Wright Wind Tunnel, and other laboratories.

**6:30 p.m.**

### Banquet

*Main Ballroom*

*Toastmaster:* R. E. Flanders, president, Jones and Lamson Machine Company, Springfield, Vt.

*Speaker:* to be announced.

Presentation of Certificates of Honorary Membership to R. E. Flanders and Irving E. Moultrop, consulting engineer, Belmont, Mass.

## THURSDAY, OCT. 3

**9:00 a.m.**

### Power (I) Session

"The Removal of Deposits From Steam Turbine Steam Passages," by Glenn B. Warren and T. W. Howard, turbine-generator division, General Electric Company, Schenectady, N. Y.

"A New Process for Removing Dissolved Silica From Water," Walter B. Leaf, Denver and Rio Grande Western Railroad Company, Denver, Colo.

### Industrial Instruments and Regulators (I) Session

"A Method for the Design of Automatic Controls," by Joel D. Peterson, Project Engineer, Eclipse-Pioneer Division, Bendix Corporation, Teterboro, N. J.

"The Analysis and Design of Servomechanisms," by Herbert Harris, Jr., senior project engineer, Sperry Gyroscope Co., Inc., Great Neck, N. Y.

### Research Committees on Metal Cutting and Bibliography and on Cutting Fluids (I) and Production Engineering (II) Session

"Finish Obtained With High-Speed Milling," by A. O. Schmidt, research engineer, charge of metal cutting, Kearney & Trecker Corporation, Milwaukee, Wis.

"Cutting Fluids," by James T. Beard, technical division, industrial, Socony-Vacuum Oil Company, New York, N. Y.

**12:15 p.m.**

### General Luncheon

*Georgian Room*

*Toastmaster:* J. N. Landis, assistant mechanical engineer, Consolidated Edison Company of New York, Inc., New York, N. Y.

*Speaker:* H. A. Winne, vice-president in charge of engineering policy, General Electric Company, Schenectady, N. Y. Subject: "Power—Where Do We Go From Here."

**2:00 p.m.**

### Plant Inspection Trip

Visit to the Mystic Station, Boston Edison Company, Everett, Mass., where visitors will be shown one of the most recent 1200-lb 900 F steam-power stations.

# Tentative Program of A.S.M.E. Petroleum Committee Annual Meeting, Tulsa, Okla., Oct. 7 to 9, 1946

THE Petroleum Committee of the Process Industries Division of The American Society of Mechanical Engineers will hold a national conference on Petroleum Mechanical Engineering at the Mayo Hotel, Tulsa, Okla., Oct. 7 to 9, 1946.

The program of the meeting follows:

## MONDAY, OCT. 7

**9:00 a.m. to noon**

### Registration

**12:00 to 2:00 p.m.**

### General Luncheon

*Tulsa Engineers' Club*

**2:00 p.m. to 5:00 p.m.**

### Oil Conditioning Symposium

*Panel Discussion:* Recognized Methods of Maintaining Lubricating-Oil Systems, by T. A. LaBrecque, Hilliard Company, Elmira, N. Y.; C. W. Bryden, De Laval Separator Company, New York, N. Y.; and Edward May, Bowser Systems, Inc., Ft. Wayne, Ind.

### Construction Materials Session

"Refinery Corrosion Problems," by E. E. Kerns, Standard Oil Company of Ohio, Cleveland, Ohio

"Mechanical and Metallurgical Control of Sulphuric Acid Corrosion in Petroleum processes," by E. R. Wilkinson, Standard Oil Company of New Jersey, Baton Rouge, La.

### Equipment Session

"Relief Valves, Their Function and Maintenance," by John Gieseke, Crosby Steam Gauge and Valve Company, Dallas, Texas

"Air-Operated Control Instruments," by V. V. Tivy, The Foxboro Company, Foxboro, Mass.

### Pumping Session

"Factors Influencing the Selection of Equipment for Oil-Well Pumping," by J. H. Field, Sohio Oil Company, Oklahoma City, Okla.

"Surface Pumping Equipment," by E. M. Fetzer, Continental Supply Company, Dallas, Texas

**8:00 p.m.**

### General Smoker

*Hotel Mayo*

## TUESDAY, OCT. 8

**9:30 a.m. to noon**

### Liquids for Air Filters Symposium

***Panel Discussion:*** "Air Filters Using Liquids for Collecting Medium," by L. L. Dollinger, Jr., Dollinger Corporation, Rochester, N. Y.; J. W. Wilson, Shell Oil Company, Inc., Wood River, Ill.; and a representative from the American Air Filter Company, Louisville, Ky.

### Construction Materials Session

"Notch-Bar Impact Properties of Some Nickel Steels After One-Year Exposure to Liquid Nitrogen," by T. N. Armstrong and A. J. Miller, International Nickel Company, New York, N. Y.

## A.S.M.E. Calendar

### *of Coming Meetings*

**September 16–18, 1946**
Industrial Instruments and Regulators Division Meeting With Instruments Society of America
Pittsburgh, Pa.

**September 30–Oct. 3, 1946**
A.S.M.E Fall Meeting
Boston, Mass.

**October 7–9, 1946**
Meeting of Petroleum Committee of Process Industries Division
Tulsa, Okla.

**October 24–26, 1946**
Joint A.I.M.E. Coal and A.S.M.E. Fuels Division Meeting
Philadelphia, Pa.

**December 2–6, 1946**
A.S.M.E. Annual Meeting
New York, N. Y.

"Some Notes on the Use of Free-Machining Steels in Connection With Petroleum Equipment," by M. E. Holmberg, Phillips Petroleum Company, Bartlesville, Okla.

### Pressure-Vessel Design Session

"Design of Pressure Vessels for High-Temperature High-Pressure Reactor Service," by E. W. Jacobson, B. M. Wedner, and T. G. Beckwith, Gulf Research and Development Co., Pittsburgh, Pa.

"Multilayer Construction of Pressure Vessels," by an engineer of Babcock and Wilcox Company, Barberton, Ohio.

### Drilling Session I

"Drilling Mud," by G. C. MacDonald, Gulf Oil Company, Tulsa, Okla.

"Recovery of Barite From Rotary-Drilling Mud," by C. J. Brown, Merco Centrifugal Company, San Francisco, Calif.

**12:30 p.m. to 2:30 p.m.**

### Group Luncheons and Business Meetings

**2:30 p.m. to 5:30 p.m.**

### Symposium on Asphalt Applications

***Panel Discussion:*** "Characteristics of Asphalts and Their Uses in Roads, Paving, Building, and Packaging," by William Raisch, consulting and chief engineer, Borough of Queens, New York, N. Y.; Russel Brown, Tilo Roofing Company, Stamford, Conn., and others to be announced later.

### Drilling Session II

"Controlled Directional Drilling of Wells," by G. L. Kothny, Sperry-Sun Well Surveying Company, Philadelphia, Pa.

"Development in Side-Wall Coring by the Rotary Method," by J. R. Yancey, A-1 Bit and Tool Company, Houston, Texas.

### Pipe-Line Pumping Session

"Rotary Pumps in the Oil Industry," by R. J. S. Pigott, Gulf Research & Development Company, Pittsburgh, Pa.

"Cavitation in Pumps," by B. R. Walsh, Gulf Research and Development Company, Pittsburgh, Pa.

"Visual Demonstration of Cavitation as Viewed by Stroboscope," by B. R. Walsh, Gulf Research & Development Company, Pittsburgh, Pa.

### Refining Equipment Session

"Suspended Wall Linings for Catalytic Regenerators and T. C. C. Kilns," by H. O. Johanson, M. H. Detrick Company, Tulsa, Okla.

"Equipment for Low-Cost Oxygen Production," by F. J. Jenney, Hydrocarbon Research, Inc., New York, N. Y.

**7:30 p.m.**

### Banquet

*Toastmaster:* R. J. S. Pigott, vice-president, Gulf Research and Development Company, Pittsburgh, Pa.

*Speaker:* E. H. Moore, senator from Oklahoma

## WEDNESDAY, OCT. 9

**9:00 a.m. to noon**

### Production Problems Session

"Significance of Fluid Properties in Gas-Condensate Reservoir Engineering," by C. K. Eilerts, U. S. Bureau of Mines, Bartlesville, Okla.

"Drilling Equipment Needs," by Douglas Ragland, Humble Oil and Refining Company, Houston, Texas

### Pipe Line Hydraulics Session

"Some Performance Data on 20-In. and 24-In. Fluid Lines," by A. N. Horne, Texas Empire Pipe Line Company, Tulsa, Okla.

"Handling Viscous Wyoming Crudes," by A. H. Newberg, Stanolind Pipe Line Company, Tulsa, Okla.

### Refining Problems Session

"Some Mechanical Difficulties in High-Temperature Cracking, and Suggested Solutions," by E. W. Griscom, Sinclair Refining Company, Marcus Hook, Pa.

"Study of Types of Serrations for Tube Rolling," by M. Q. Colton, Ohio Steel Foundry Company, Lima, Ohio

### Construction Materials Session

"Use of Stellite and Other High Alloyed Materials to Combat Corrosion and Abrasion in the Petroleum Industry," by C. G. Chisholm Haynes Stellite Company, Kokomo, Ind.

"Controlled Structure of Cast Iron for Wear Resistance," by F. G. Sefing, International Nickel Company, New York, N. Y.

**12:30 p.m. to 2:00 p.m.**

### Luncheons and Business Meetings

**2:30 p.m. to 5:00 p.m.**

### Refining Problems Session

"Hydraulic De-Coking," by an engineer of Worthington Pump & Machinery Corp., Harrison, N. J.

"New Development in Compressors for Petroleum-Industry Applications," by J. N. MacKendrick, Clark Bros., Co., Olean, N. Y.

### Tubular Equipment Session

"A Study of the Corrosion of Condenser Tubes and Effect on Mechanical Properties," by N. W. Mitchell, Chase Brass & Copper Co., Waterbury, Conn.

"Heat Exchangers for Field Application," by D. E. Fields, Tulsa Boiler & Machinery Co., Tulsa, Okla.

## 1946 National Power Show to Be Held in New York, N. Y., Dec. 2–7, 1946

THE 17th National Exhibit of Power will be held at the Grand Central Palace, New York, N. Y., Dec. 2 to 7, 1946. The list of innovations promised and the number of exhibitors who have contracted for space indicate that the 1946 National Power Show will be the largest ever held.

The A.S.M.E. 1946 Annual Meeting will be held in New York, N. Y., during the week of the National Power Show.

# President's Page

## *What Is E. J. C.?*

As I talked with our engineering groups and with individuals this year in the East, in the Middle West, and in these recent weeks with our members in the Los Angeles and San Francisco areas and in Portland, Seattle, and Spokane, I was concerned to discover that many A.S.M.E. members do not know about the Engineers Joint Council and its program, even though they all seem interested in the broad question of engineering unity.

The Engineers Joint Council, founded in October, 1941, is composed of the president, junior past-president, and secretary of A.S.C.E., A.I.M.E., A.S.M.E., A.I.E.E., and A.I.Ch.E. E. J. C.—with the aid of many fellow-engineers—has successfully co-ordinated the activities of these five leading societies with a combined membership of over 85,000, on matters of wartime co-operation with the government, postwar adjustments, intersociety co-ordination, relations with other engineering groups, and co-operation with international groups.

E. J. C.'s National Engineers Committee, at the request of the State and War Departments, prepared comprehensive reports on the industrial disarmament of Germany and Japan which have had a decided influence on our government's policies there. The recommendations of the report on Germany were substantially all included in the directive of the Allied Control Council of March 29, 1946, for the limitation and control of German industry. The report on Japan likewise has positive and continuing military and industrial disarmament as its ultimate goal, recognizing that ruthless and indiscriminate destruction of all industry and of a sustaining national economy will defeat the re-establishment of peace and the eventual admission of Japan into the councils of peaceful nations.

E. J. C.'s Committee on Organization of the Engineering Profession is now engaged in an important study of the local organization of engineering societies.

E. J. C.'s Committee on the Economic Status of the Engineer has a comprehensive program under way to improve the economic position of the engineer. This work is divided among three main subcommittees on Survey of Employer Practices Regarding Engineering Graduates, on Survey of the Engineering Profession, and on Collective Bargaining—the latter of which is of great interest to many groups.

E. J. C. is giving very active support to the Engineers' Council for Professional Development in its expanding program on student selection and guidance, on engineering schools, on professional training, on professional recognition, on engineering ethics, on employment conditions for engineers, and related matters.

E. J. C. has just been selected to serve on the National Commission of the United Nations Educational, Scientific, and Cultural Organization.

E. J. C., as an interim body, guides and speeds the evolution of a permanent agency to coordinate engineering-society activities on the national, regional, state, and local council levels.

The program is now well under way to secure a general participation by the members of the five societies in forming future policies.

We count on your sharing fully in this program!

D. ROBERT YARNALL, *President*, A.S.M.E.

# E. O. Lawrence Receives the Holley Medal of A.S.M.E. at Annual Meeting of Los Angeles Engineering Council

## H. S. Aurand Speaks on Army Research Program

ERNEST ORLANDO LAWRENCE, director, Radiation Laboratory, University of California, Nobel Prize winner in physics in 1939, was presented the Holley Medal of The American Society of Mechanical Engineers before 760 members and guests at the annual meeting of The Los Angeles Engineering Council of Founder Societies held at the Biltmore Hotel, Los Angeles, Calif., July 26, 1946.

The medal was awarded to Dr. Lawrence in 1942 in recognition of his invention of the cyclotron, but was not presented at the time because of war conditions.

### Engineering Responsibilities

In presenting the medal to Dr. Lawrence, President Yarnall said:

"Engineers are always expected by their countrymen to carry their full share of the load in national crises. Great as was the urge to co-operation during the war when we were aware of common danger, the challenge of living and growing together in peace is still greater in these postwar days.

"The need for national well-being, for the common good in which all share, is a challenge to our citizenship and our human relationships.

"In presenting this Medal to Dr. Lawrence, we do so with special appreciation for his long career of useful research in physics and we welcome this opportunity particularly in order to emphasize the important peacetime results of his work.

"We have all been shocked by the destructive possibilities of the atomic bomb. Its achievements and its dangers occupy the headlines of our papers and are the subject of comments by laymen in all fields of endeavor We are often prone to forget the tremendous possibilities of the advances in science for the increased convenience and happiness of human beings and we are confident that the splendid work done by Dr. Lawrence, for which he is awarded the Medal tonight, will have great future possibilities for advancing human well-being.

"Dr. Lawrence, I present to you the Holley Medal of The American Society of Mechanical Engineers for 'your work in originating the cyclotron, a unique invention for producing high-speed electrified particles, and for adapting it to research in physics, chemistry, medicine, and the properties of engineering materials.' In doing so we hope that your work will continue with great success and its fruits will be of increasing use to mankind."

Following the presentation, Dr. Lawrence spoke on "Atomic Engineering." "Many of us alive today," he said, "could see the growth of a very substantial atomic-energy industry."

Dr. Lawrence said that he was looking forward to the fall when the great 184-inch clycotron, construction of which was halted during the war, is turned on. "There are more than 4000 tons of steel and 300 tons of copper windings in the magnet," he stated, "and we hope eventually to be doing scientific work in the region of 400,000,000 volts of the atom."

As guest speaker at the meeting, Henry S. Aurand, major general, U. S. Army, director of the newly created Research and Development Division of the War Department General Staff, spoke on "The Army's Research Program." He called upon civilian engineers and scientists to continue in peacetime the co-operation developed during the war; told how the Army had inaugurated five policies to insure civilian influence not only in development and procurement activities but also in long-term planning for national defense; and announced the creation of the Joint Research and Development Board.

Other speakers at the dinner were C. E. Davies, secretary, A.S.M.E., and J. Calvin Brown, vice-president A.S.M.E., Region VII, and president of The Los Angeles Engineering Council of Founder Societies.

General Aurand, who is a native of Pennsylvania, a West Point graduate of the class of 1915, and former Commanding General of the Sixth Service Command, the Normandy Base Section in France, and the China Theater Services of Supply, complimented American engineers and scientists as "the primary research and development asset of the nation both in peace and in war." He stated, "Our common goal for the future is to organize a research and engineering team of civilian and military personnel whose material and social accomplishments will guarantee to our country the security and freedom from fear so necessary to the future existence of the American way of life."

### Five New Policies

To achieve this goal of teamwork, General Aurand said that General Dwight Eisenhower, Army Chief of Staff, inaugurated five policies which in Eisenhower's words would "not merely familiarize the Army with the progress made in science and industry" but would draw into top level Army planning for national defense "all the civilian resources which can contribute to the defense of the country."

He stated the policies as: (1) The Army must have civilian assistance in military planning as well as for the production of weapons. (2) Scientists and industrialists must be given the greatest freedom to carry out their research. (3) The possibility of utilizing some

*Courtesy Los Angeles Times*

PRESIDENT YARNALL PRESENTING THE HOLLEY MEDAL TO E. O. LAWRENCE AT THE ANNUAL MEETING OF THE LOS ANGELES ENGINEERING COUNCIL OF FOUNDER SOCIETIES, JULY 26, 1946

MAJOR GENERAL HENRY S. AURAND, DIRECTOR, RESEARCH AND DEVELOPMENT DIVISION, WAR DEPARTMENT GENERAL STAFF

of our industrial and technological resources as organic parts of our military structure in time of emergency should be carefully examined. (4) The Army must separate responsibility for research and development from the functions of procurement and distribution. (5) Officers of all arms and services must become fully aware of the advantages which the Army can derive from the close integration of civilian talent with military plans and developments.

The first of these policies has already been implemented by the creation of a War Department Civilian Panel of outstanding scientists and engineers, and in accordance with the fourth policy, the Army has already established the Research and Development Division as a staff function on the same level as Service, Supply, and Procurement Division.

The full text of General Aurand's address is published on pages 785 and 786 in this issue of MECHANICAL ENGINEERING.

## New Studies in Engineering Physics Established at Cornell University

A NEW department of engineering physics, which offers a five-year curriculum leading to a bachelor degree in engineering physics, is to be opened at Cornell University, Ithaca, N. Y., Sept., 1946.

The new course of studies is designed to bridge the area of training between basic science and fundamental engineering and to train students for careers in research and development.

Lloyd P. Smith, in addition to his post as chairman of the department of physics, serves as director of the new department.

## A.S.M.E. Publishes Metal Cutting Data Sheets

WITH the release of the July, 1946, issue of the Metal Cutting Data Sheets, The American Society of Mechanical Engineers makes available to industry timely factual information about cutting tools and methods, and particularly new information on the use of carbide-tipped tools, culled each month from research-laboratory reports and industrial sources.

The new publication is an outgrowth of the Metal Cutting Data Sheets published during the war by the Society for the Office of Production Research and Development of the War Production Board as an aid to the war effort. The former publication, 10,000 sets of which were distributed free throughout industry, was primarily devoted to milling data obtained as a result of government-sponsored research at the California Institute of Technology, Pasadena, Calif., and the University of Michigan, Ann Arbor, Mich.

As an A.S.M.E. publication, however, the Metal Cutting Data Sheets have a much broader scope and aim to cover the metal-cutting field under ten different classifications.

With the end of the war and the termination of government sponsorship, publication of the Metal Cutting Data Sheets had to be discontinued. Engineers and executives who had been benefiting from the convenient information made available by free publication continued to ask for a continuation of the Data Sheets, even if at some cost to the recipients.

In response to this demand and as a service to industry, The American Society of Mechanical Engineers resumed publication of the Data Sheets in July, 1946, on a self-supporting nonprofit basis.

The Data Sheets are issued in the form of $8^1/_2 \times 11$-in. punched loose-leaf pages for convenient filing in a folder. Subject matter is presented under ten divisions of the metal-cutting industry. Each subscriber is provided with a set of index cards to facilitate filing.

Subscription fee for 12 issues of the Metal Cutting Data Sheets is $15 in the United States. Subscriptions should be addressed to The American Society of Mechanical Engineers, Publication Sales Department, 29 West 39th Street, New York 18, N. Y.

## Interpretations of Safety Code for Elevators

AT the meeting on June 12, 1946, of the Sectional Committee on the Safety Code for Elevators, "interpretations" of the Code issued from June, 1945, to June, 1946, by the executive committee in tentative form, were approved and transmitted to MECHANICAL ENGINEERING for publication, as follows:

*Interpretation No. 4, 1945.* (Rules 124f and 224r3)

QUESTION: In view of the wording of Rule 224r3 can hoistway gates be used with limited speed automatic- and continuous-pressure-operation freight elevators?

ANSWER: Yes. Continuous-pressure- and automatic-operation freight elevators having a speed not in excess of 150 fpm may be provided with gates meeting the requirements of Rule 124f.

*Interpretation No. 5, 1945.* (Rules 201a and 201b)

QUESTION: May a short stroke buffer (as permitted in the exception to rule 201a) be pre-compressed?

ANSWER: Where a reduced stroke oil buffer is used as permitted by Rule 201a and its exception, the words "the remaining buffer stroke shall be not less than fifty (50) per cent of the gravity stopping distance corresponding to the governor-tripping speed used" shall be interpreted to mean 50 per cent of the gravity stopping distance used to determine the reduced buffer stroke as provided in Rule 201a and its exception.

*Interpretation No. 6, 1945.* (Rule 404)

QUESTION: Under the wording of Rule 404 may chains be used as suspension members for dumbwaiters?

ANSWER: No. Rule 404 as now worded does not permit the use of chains as a hoisting means for dumbwaiters.

However, it is the consensus of the committee that emergency action would be recommended to the Sectional Committee to permit the use of chains as a hoisting means with suitable limitations including a minimum factor of safety dependent on speed.

*Interpretation No. 7, 1945.* (Rules 100 and 212g)

QUESTION: Are fire-resistant car doors and hoistway doors required in a brick hoistway built outside of the building line where the building itself is not of fire-resistant construction?

ANSWER: Fire-resistant car doors would not be required under Rule 212g.

Where no local building code governs it is the intent of Rule 100b to call for fire-resistant doors *only where fire-resistant enclosures are required by Rule 100a.* However, attention is called to the note under Rule 100a recommending fire-resistant inclosures (including doors) for all elevator hoistways.

*Interpretation No. 8, 1945.* (Rule 124f)

QUESTION: Is paragraph 6 of Rule 124f (reading "If horizontally sliding or swinging or combination sliding and swinging landing doors are used interlocks shall be provided irrespective of the contract speed") one of the "conditions" referred to in paragraph 3 applying only to automatic- and continuous-pressure-operation elevators or does it apply to car-switch or any other type of operation; in other words, does it require interlocks on hoistway doors on every freight elevator irrespective of speed or type of operation where horizontally sliding or swinging, or combination sliding and swinging landing doors are used?

ANSWER: It was the intent of the Committee in drafting Rule 124f that only the first 3 paragraphs immediately following the colon in paragraph 3 of the rule should apply exclusively to automatic- and continuous-pressure-operation elevators and that these three paragraphs should have been indented to so indicate. It was further the committee's intent that paragraphs 4 and 5 of this rule, following the colon in paragraph 3 should apply irrespective of the type of operation and should not have been included as conditions applying only to automatic- and continuous-pressure-operation elevators.

*Interpretation No. 9, 1945.* (Rules 124f and 121)

QUESTION: In the case of vertical bi-parting doors, are the requirements of Rules 124f and 121 fully met if the interlock or mechanical lock locks only the lower half of the door and no lock is provided which locks the two halves of the door together?

ANSWER: A bi-parting door provided with a lock on the lower section meets the requirement of Rule 121a(2) in that this will "prevent the opening of the hoistway door from the landing side unless the car is at rest within the landing zone or is coasting through the landing zone with its operating device in the stop position."

*Interpretation No. 10, 1946.* (Rule 103b)

QUESTION: What is the pit depth of an elevator having a contract speed of less than 100 fpm?

ANSWER: The last paragraph of this rule on page 32 requires a clear space of two feet between the lowest projection on the under side of the car and the pit floor when the car is resting on the fully compressed buffer. The distance from the top of the car platform to the striker plate, plus the clearance between striker plate and spring when the car is at the lower terminal landing, plus the buffer compression, plus 2 feet, would normally give the required pit depth.

# American Engineers Plan to Participate in Two International Congresses

A PARTY of more than 20 American engineers plans to depart by air from New York for Paris, Sept. 6, 1946, to participate in the International Technical Congress to be held at the Maison de la Chimie, Sept. 16 to 21, 1946, and the Sixth International Congress for Applied Mechanics, to be held at the Sorbonne, Sept. 22 to 29, 1946. This delegation will increase to more than fifty, the number of American scientists and engineers who intend to participate in the Congresses.

### International Technical Congress

A. Antoine, president, French Union of Engineers and Technicians, and P. Chalon, president, The Society of Civil Engineers of France, invited American engineers to participate in the International Technical Congress, the purpose of which is "to emphasize the universal character of the great engineering problems arising out of the reorganization and development of world economy."

The American program will present American engineering philosophy as typified by American accomplishments under the following four topics suggested by the French Committee: (1) Economics development of an area; (2) nuclear energy; (3) present situation of engineering in the United States; and (4) engineers in the United States.

Among those participating will be: Harry A. Winne, member A.S.M.E., vice-president, General Electric Company; John Willard, member A.S.M.E., chairman, National Management Council; Morris Llewellyn Cooke, fellow A.S.M.E., and C. E. Davies, secretary, A.S.M.E.

### Applied Mechanics Congress

Six technical and scientific societies of France are sponsors of the Sixth International Congress for Applied Mechanics. The Congress will hear and discuss papers on elasticity, plasticity, hydrodynamics and aerodynamics, vibration and sound, friction and lubrication, heat transfer, and many other subjects.

As part of the American contribution to the Congress, Hugh L. Dryden, member A.S.M.E., associate director, Bureau of Standards, will present a paper on "Some Recent Contributions to the Study of Transition and Turbulent Boundary Layers." Thirty-five American engineers are expected to participate.

### American Committee

United States participation in both Congresses was sponsored by the Committee on American Participation, which consists of: C. E. Davies, chairman, secretary A.S.M.E.; W. N. Carey, secretary, A.S.C.E.; H. H. Henline, secretary, A.I.E.E.; A.B. Parsons, secretary, A.I.M.E.; and S. L. Tyler, secretary, A.I.Ch.E.

# British Engineers Honor William L. Batt

WILLIAM L. BATT, past-president and honorary member, A.S.M.E., has been elected to honorary membership in The Institution of Mechanical Engineers by a unanimous vote of the Council of the Institute.

Mr. Batt, who served on the Combined Production and Resources Board during the war, was recently made honorary companion of the Order of St. Michael and St. George by King George VI. Mr. Batt will fly to England to accept the honorary membership at the meeting of the Institution on Sept. 6, 1946.

GROUND-BREAKING CEREMONIES AT THE GEORGIA SCHOOL OF TECHNOLOGY, ATLANTA, GA.

(On June 11, 1946, the Georgia School of Technology started a $12,500,000 building program with ground-breaking ceremonies for $4,000,000 of permanent housing consisting of one eight-story elevator-apartment house for 64 married veterans, eight groups of three-story apartment houses for 158 married veterans, and three dormitories for 923 single verteans. It is expected that the units will be ready for occupancy by Sept., 1947. *Left to right:* Phillip B. Narmore, dean, member A.S.M.E., D. C. Kyker, president, student council; Blake R. Van Leer, president, member A.S.M.E.; C. L. Emerson, dean, member A.S.M.E.; and F. Spratlin, regent, State of Georgia.)

# E.J.C. 1946 Survey of Engineering Profession Being Conducted With Co-Operation of U. S. Bureau of Labor Statistics

## A.S.M.E. Members Urged to Return Forms

IN a self-analysis of unprecedented magnitude, America's engineering profession, in co-operation with the Bureau of Labor Statistics, U. S. Department of Labor, is conducting a survey on the economic status of the nearly 100,000 members of the societies comprising Engineers Joint Council—the American Society of Civil Engineers, the American Institute of Mining and metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers. The survey also includes the National Society of Professional Engineers, which is participating.

### Object of Survey

An up-to-date foundation for evaluating the educational needs and professional opportunities of the engineering profession is the objective of the survey, which is under way after more than a year of preparation and study. The undertaking is sponsored by Engineers Joint Council's Engineer Survey Committee, a subcommittee of the E.J.C. Committee on the Economic Status of the Engineer. William N. Carey, executive secretary, A.S.C.E., is chairman.

### Government Co-Operates

The physical conduct of the survey is being done by the Bureau of Labor Statistics, which is equipped to handle this type of precoded questionnaire, in which participants remain anonymous. The Committee has engaged as consultant and liaison with the Bureau, Andrew Fraser, Washington, D. C., who prepared a comprehensive report on a similar survey conducted by the Bureau in 1935.

Calling for information which can be supplied readily and simply, the questionnaire is being mailed to each member of the participating engineering bodies, together with an explanatory letter signed by Ewan Clague, Commissioner of Labor Statistics. Replies will be tabulated by code on machines in the Bureau which are especially designed for such work.

The questionnaire, part of which is reproduced on this page, is not "just another government questionnaire." It is a study being made by the A.S.M.E. and paid for in part by members' dues. The questionaire comes to members from the Bureau of Labor Statistics only because the Bureau is equipped to conduct and tabulate the findings of such a precoded survey and has consented to co-operate with The American Society of Mechanical Engineers and other engineering societies participating in the E.J.C. study of the economic status of the engineer.

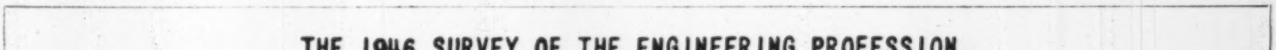
### Forms Are Anonymous

Emphasis is placed on the need for complete and correct responses to the questionnaire, since anonymity makes checking impossible, and incompleteness, even of one question, automatically excludes all other data in the question from tabulation.

A deadline for receipt of completed questionnaires has been set for Nov. 15, 1946, after which Mr. Fraser will proceed with preparation of a report based on the replies.

### Members Urged to Answer and Return Forms

A.S.M.E. members are urged to fill out questionnaire and return it promptly using the addressed envelope furnished for their convenience.



THE 1946 SURVEY OF THE ENGINEERING PROFESSION

Committee On The Economic
Status Of The Engineer
ENGINEERS JOINT COUNCIL

Cooperative Project
In
Cooperation With The

Bureau Of Labor Statistics
U.S. DEPARTMENT OF LABOR
Washington 25, D. C.

NOTE 1: *Questions 1 to 6 inclusive require merely that you circle one and only one of the code numbers.*

1. AGE LAST BIRTHDAY *(in years)* ________

2. SEX: Male. . . . . . . . . 1 Female. . . . . . . . . . .2
*(Circle one and only one of these two code numbers)*

3. YEAR OF ENTERING PROFESSION: Indicate below the year in which you drew your first salary in your professional field.

1899 *(or before)* -

19 - 00 01 02 03 04 05 06 07 08 09
10 11 12 13 14 15 16 17 18 19
20 21 22 23 24 25 26 27 28 29
30 31 32 33 34 35 36 37 38 39
40 41 42 43 44 45 46

*(Circle one and only one of these forty-eight code numbers)*

4. FORMAL EDUCATION IN A NON-ENGINEERING FIELD: If you received education in a non-engineering field indicate below the highest educational level reached by you *(excluding honorary degrees)*.

Doctor. . . . . . 1 Master . . . . . . . . . . . 2
Bachelor. . . . . 3 Incomplete College . . . . 4

*(Circle one and only one of these four code numbers)*

5. FORMAL EDUCATION IN A BASIC ENGINEERING FIELD: Indicate below the highest educational level reached by you in a basic engineering field *(excluding honorary degrees)*.

| Basic engineering field | Educational Level<br>Doctor | Master | Bachelor | Incomplete college training | No college training |
|---|---|---|---|---|---|
| Chemical engineering . . . . . . . . . . . | 11 | 12 | 13 | 14 | 15 |
| Civil engineering. . . . . . . . . . . . . | 21 | 22 | 23 | 24 | 25 |
| Electrical engineering . . . . . . . . . . | 31 | 32 | 33 | 34 | 35 |
| Mechanical engineering . . . . . . . . . . | 41 | 42 | 43 | 44 | 45 |

ANSWER THESE QUESTIONS. ANSWER QUESTIONS COMPLETELY. USE ADDRESSED ENVELOPE. PLEASE DO IT NOW

# A.S.M.E.-A.I.M.E. Ninth Joint Fuels Conference

## To Be Held in Philadelphia, Pa., Oct. 24 and 25, 1946

THE Ninth Joint Fuels Conference sponsored by the Fuels Division of the American Society of Mechanical Engineers and the Coal Division of the American Institute of Mining and Metallurgical Engineers will be held at the Bellevue Stratford Hotel, Philadelphia, Pa., Oct. 24 and 25, 1946.

The two-day program will consist of technical sessions, two luncheons, a banquet, and inspection trips to near-by industrial plants. The tentative program follows:

### THURSDAY, OCT. 24

#### Morning Session

"Cinder and Fly-Ash Factors When Burning Small Anthracite on Traveling-Grate Stokers," by C. S. Gladden, member A.S.M.E., Cherokee Ordnance Works, Hayden Chemical Corporation, Danville, Pa.

"Fine-Coal Cleaning in the Netherlands," by M. G. Driessen, member A.I.M.E., chief, mining-research department, Staatsmijnen, Limberg, Netherlands.

"Studies of Coal Plasticity as Related to Coal Carbonization," by C. C. Russell, member A.I.M.E., chemical engineer, Koppers Company, Kearny, N. J.

#### Afternoon Session

"Combustion of Anthracite in Glass Tubes," by R. C. Johnson, member A.S.M.E., vice-president, Anthracite Institute, Wilkes-Barre, Pa.

"Grinding of Anthracite for Pulverized Fuel," by C. H. Frick, member A.S.M.E., plant-betterment engineer, Power and Light Company, Allentown, Pa.

### FRIDAY, OCT. 25

#### Morning Session

"Heavy-Duty Equipment Used in Trucking, Blasting, Drilling, etc., in Stripping," by D. R. Mitchell, member A.I.M.E., The Pennsylvania State College, State College, Pa.

"Newkirk Tunnel Mining Practices," by G. A. Roos, member A.I.M.E., manager, Philadelphia and Reading Coal and Iron Company, Pottsville, Pa.

"Mining Pennsylvania Bituminous Coal," by Richard D. Snouffer, member A.I.M.E., The Pennsylvania State College, State College, Pa.

#### Afternoon Session

*Panel Discussion:* Why So Many Sizes of Coal, Chairman, E. C. Payne, Consulting Engineer, Consolidated Coal Company, Pittsburgh, Pa.

#### Plant Trips

Tentative plans are being made to visit the following plants: New Southwark generating station, Philadelphia Electric Company, stoker manufacturing plant of the American Engineering Company, White Glove Package Fuel Division of Blaw-Knox Company, Philadelphia Navy Yard, Westinghouse Electric Corporation, and the Edward G. Budd Manufacturing Company.

#### Committee

The General Committee of the Joint Fuels Conference consists of the following: N. E Funk, chairman; H. B. Allen, co-chairman; F. R. Miller, assistant to chairman; and L. C. Bosler, Herbert Estrada, A. W. Grosvenor, A. L. Jamieson, Allan J. Johnson, Raymond C. Johnson, Albert G. Kisner, R. W. Leiter, Justin J. McCarthy, Sidney T. Mackenzie, H. Markus, H. W. Montz, Stanley Moyer, M. C. Randall, T. A. Read, H. Rosenthal, A. W. Thorson, Benjamin W. Webb.

#### Reservations

The Committee suggests that members planning to participate in the Conference make reservations directly with the Bellevue-Stratford Hotel.

# Attendance at Semi-Annual Meeting

OFFICIAL attendance at the A.S.M.E. Semi-Annual Meeting, Detroit, Mich., June 17 to 20, 1946, was 1238. Of this number, 572 were members, 561 guests, 83 women, and 22 students.

Engineers from the Detroit area accounted for about one third of the attendance. A delegation of more than a hundred attended from Michigan and Ohio. Sixty-two attended from Canada, while the Metropolitan, Pennsylvania, and Illinois Sections each sent a delegation numbering over fifty.

Members from 35 states, Canada, and two foreign countries, Denmark and Turkey, participated in the meeting.

# O. A. Leutwiler Honored by Alumni

THE alumni of the University of Illinois and the A.S.M.E. Central Illinois Section are raising a fund to establish the O. A. Leutwiler Award to be given annually to the two outstanding seniors in mechanical engineering. The fund is an expression of the affection and gratitude of former students for O. A. Leutwiler, member A.S.M.E., who has retired after 42 years as professor and friendly counselor at the University of Illinois.

MEMBERS OF THE NATIONAL BOARD OF BOILER AND PRESSURE-VESSEL INSPECTORS AT THE SIXTEENTH ANNUAL MEETING AT HOTEL WINDSOR, MONTREAL, QUEBEC, CAN., JUNE 25 TO 27, 1946

# One Hundred Eminent Physicists to Participate in Joint A.P.S. and A.S.M.E. Meeting in New York, N. Y., Sept. 19 to 21

ONE hundred eminent physicists from many countries of the world will discuss the latest accomplishments and discoveries in nuclear physics during a three-day meeting sponsored jointly by the Metropolitan Sections of The American Physical Society and The American Society of Mechanical Engineers. The meeting will be held at the Engineering Societios Building, New York, N. Y., Sept. 19 to 21, 1946.

Scientists from Brazil, Mexico, Ireland, Denmark, Sweden, France, England, India, Russia, Italy, and the United States will discuss three topics on subatomic physics during seven sessions.

### Benefit to Engineers

The announcement of the meeting addressed to engineers says:

"Engineers are too often unmindful of the fact that physics is the mother science upon which their profession is based and that engineering is but the common name for the science of applied physics. They are therefore inclined to drift farther and farther away from the fountain-head of knowledge on which our entire careers depend.

With this in mind the Metropolitan Section of The American Society of Mechanical Engineers has arranged a joint meeting with technologists of the mother science in order that they may learn at first hand of the recent accomplishments and discoveries which have shaken the world to its very foundations.

It is the task of engineering to harness the gigantic new forces discovered by physics for the benefit rather than the destruction of mankind.

The September Joint Meeting will be one of the most significant ever held and will bring together the greatest scientific minds of the entire world. It is hoped that the members of The American Society of Mechanical Engineers will take full advantage of this opportunity to co-operate with the members of The American Physical Society in the advancement of technology and the betterment of the world."

The program follows:

### Program

### THURSDAY, SEPT. 19

10:00 a.m. *Room 502*

***Subatomic Particle Accelerators***

*Chairman:* L. Alvarez, University of California

10:00 a.m. *Room 501*

***Cosmic Ray and Subnucleoric Physics***

*Chairman:* E. U. Condon, National Bureau of Standards

2:15 p.m. *Auditorium*

***Subatomic Particle Accelerators***

*Chairman:* L. A. Dubridge, University of Rochester

4:15 p.m. *Auditorium*

***Discussion***

*Chairman:* G. Suits, General Electric Company

### FRIDAY, SEPT. 20

10:00 a.m. *Room 501*

***Theories of Elementary Particles***

*Chairman:* G. G. Hyde, The American Society of Mechanical Engineers

2:15 p.m. *Rooms 501 and 502*

***Theories of Elementary Particles***

*Chairman:* Karl K. Darrow, Bell Telephone Laboratories, Inc.

4:15 p.m. *Rooms 501 and 502*

***Discussion***

*Chairman:* J. R. Oppenheimer, University of California

7:00 p.m.

*Faculty Club of Columbia University*
*400 West 117 Street, New York, N. Y.*

***Dinner***

(For reservations write to Karl K. Darrow, The American Physical Society, Columbia University, New York 17, N. Y.)

### SATURDAY, SEPT. 21

9:30 a.m. *Room 501*

***Cosmic Ray and Subnucleonic Physics***

*Chairman:* L. A. DuBridge, University of Rochester

2:15 p.m. *Auditorium*

***Cosmic Ray and Subnucleonic Physics***

*Chairman:* E. U. Condon, National Bureau of Standards

4:15 p.m. *Auditorium*

***Discussion***

*Chairman:* P. M. S. Blackett, University of Manchester, England

### Participants

The following scientists will participate in the discussions:

*American Institute of Physics*, H. A. Barton; *Ballistics Research Laboratory, Aberdeen, Md.*, T. H. Johnson; *Bell Telephone Laboratories*, Karl K. Darrow; *California Institute of Technology*, Carl Anderson; *Case School of Applied Science*, E. F. Shrader.

*Clinton Laboratories*, D. Saxon, A. H. Snell, R. B. Sawyer, E. O. Wellan, K. C. Peterson, and S. Bernstein; *Columbia University*, George B. Pegram, A. Nordsieck, and I. I. Rabi, *Cornell University*, E. D. Courant, H. A. Bethe, and R. P. Feynman; *Dublin Institute for Advanced Studies*, L. Rosenfeld, W. Heitler.

*General Electric Company*, H. C. Pollock, R. V. Langmuir, F. R. Elder, J. P. Blewitt, A. M. Gurewitch, R. L. Watters, E. J. Lawton, W. C. Hahn, L. Tonks, G. Suits, G. F. Kliber, E. A. Luebke, G. C. Baldwin, G. Friedlander, and M. Perlman; *George Washington University*, C. L. Critchfield; *Harvard University*, J. Schwinger and R. R Wilson; *The Institute for Advanced Study*, W. Pauli; *Institute for Teoretisk Fysik*, A. Pais; *Laboratoire de L'Ecole Polytechnique*, L. LePrince-Ringuet; *Laval University*, F. Rasetti.

*Massachusetts Institute of Technology*, R. J. Van de Graaff, W. W. Buechner, W. M. Woodward, L. R. McIntosh, E. A. Burrill, A. Sperduto, J. C. Slater, T. A. Welton, V. Weisskopf, and Bruno Rossi; *Metallurgical Laboratory*, Donald J. Hughes; *The American Society of Mechanical Engineers*, G. G. Hyde; *National Bureau of Standards*, E. U. Condon; *Princeton University*, John A. Wheeler, Lloyd G. Lewis, G. N. Plass, E. P. Wigner, and Shuichi Kusaka; *Purdue University*, E. S. Akeley, A. Ginzbarg, R. O. Haxby, H. W. Welch, R. M. Whaley, and R. N. Smith.

*Tata Research Institute, Bombay*, H. J. Bhabha; *U.S.Naval Research Laboratories*, E. C. Greanias E. O. Wukasch, and H. F. Kaiser; *University of Birmingham*, R. E. Peierls, and H. McManus; *University of California*, R.T. Birge, L. Alvarez, W. B. Fretter, R. B. Brode, E. McMillan, E. O. Lawrence, David Bohm, J. R. Oppenheimer, R. Serber, and Wayne Hazen; *University of Cambridge, England*, H. Carmichael, C. N. Chou, and P. A. M. Dirac; *University of Ceylon, India*, C. J. Eliezer; *University of Chicago*, E. Fermi and Marcel Schein; *University of Copenhagen*, Niels Bohr and J. C. Jacobsen; *University of Illinois*, D. W. Kerst; *University of Manchester, England*, P. M. S. Blackett; *University of Mexico*, M. S. Vallarta and M. L. Perusquia; *University of Michigan*, H. R. Crane; *University of Minnesota*, John T. Tate; *University of Pennsylvania*, L. I. Schiff; *University of Rochester*, L. A. DuBridge; *Universidade de Sao Paulo, Brazil*, Gleb Wataghin, J. de Oyarzabal, and Carlos Graef-Fernandez.

### Albert Einstein to Attend

In addition to physicists participating in the program many others are expected to attend the various panels. Albert Einstein of relativity and $E = mc^2$ fame, Henry DeWolf Smyth, author of the famous report on "Atomic Energy for Military Purposes," H. C. Urey and J. R. Dunning are expected to be present.

## New York Engineers Form Engineering Council

FOURTEEN local chapters of engineering, scientific, and technical societies in Greater New York have joined in the formation of the Engineering Societies Council of New York.

The purpose of the new organization is to co-ordinate the programs of the participating organizations in the interest of the public and the engineering profession.

Harold C. R. Carlson, member A.S.M.E., has been elected chairman of the new Council.

Other officers are: Vice-chairman, H. P. Wall, American Society of Safety Engineers; secretary, M. P. Davis, American Society for Testing Materials; treasurer, H. F. Dart, Institute of Radio Engineers; directors, O. B. J. Fraser, American Institute of Mining and Metallurgical Engineers; E. J. Lyons, American Institute of Chemical Engineers; W. F. O'Connor, American Chemical Society; C. S. Purnell, American Institute of Electrical Engineers; H. J. Ryan, American Society of Heating and Ventilating Engineers; and E. M. Sherwood, American Society for Metals.

Local chapters of the following societies are participating in the new organization: American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, American Society of Heating and Ventilating Engineers, American Society for Metals, American Society of Safety Engineers, American Society for Testing Materials, American Society of Tool Engineers, American Chemical Society, American Welding Society, Illuminating Engineering Society, Institute of Radio Engineers, and the Society of Motion Picture Engineers.

### The Rumford Fund

THE directors of The Rumford Fund of the American Academy of Arts and Sciences announce that grants are available for support of original researches in the fields of heat and light, broadly interpreted.

Engineers, scientists, or students who require assistance, are encouraged to submit applications in the form of a letter describing briefly, the research that is in progress, the nature of the assistance needed, the support that is already being provided by the institution with which the applicant is connected, and other relevant details, to Dr. Harlow Shapley, The Harvard Observatory, Cambridge, Mass.

Communications from the endorsers of the research project for which assistance is sought would be of service to the directors of the Fund.

Grants from The Rumford Fund have rarely been made in excess of $400 or $500.

HAROLD C. R. CARLSON, CHAIRMAN, ENGINEERING SOCIETIES COUNCIL OF NEW YORK

## N.A.C.A. Dedicates New Wind Tunnel

A twelve-foot low-turbulence-pressure wind tunnel built by the National Advisory Committee for Aeronautics at its Ames Aeronautical Laboratory, Moffett Field, Calif., was dedicated July 16, 1946, by Dr. William F. Durand, past-president and honorary member, A.S.M.E., professor emeritus of mechanical engineering, Stanford University.

The new tunnel is of sufficient size to accommodate airplanes as large as full-scale attack bombers and small transport aircraft. Its facilities for accurate control of air speed, turbulence, and density make possible close simulation of full-scale flight conditions. As a new scientific instrument, the tunnel is expected to hasten aeronautical research.

The distinctive shape of the tunnel, which incorporates a working section of 12 ft diam, an antiturbulence sphere of 68 ft maximum diam and two U-turns in its total length of 336 ft, was dictated by the need for providing nonturbulent air flow at high speed and high pressure. Two fans of 22 ft, 8 in. diam, coupled to drive motors rated at 11,000 hp, are capable of creating air speeds up to 750 mph.

An illustrated brochure "N.A.C.A. Twelve-Foot Low-Pressure Wind Tunnel" published by the National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory, Moffett Field, Calif., describes the architectural features of the tunnel, the engineering considerations that dictated them, and the machinery and instruments layout.

## A.S.M.E. Members Honored by Pi Tau Sigma

THE Northwestern University branch of Pi Tau Sigma, honorary mechanical-engineering fraternity, conferred honorary membership on Alex D. Bailey, past-president and fellow A.S.M.E., and John P. Magos, past-chairman, A.S.M.E. Chicago Section, director of research, Crane Company, Chicago, Ill., at a meeting on May 20, 1946.

# Actions of the A.S.M.E. Executive Committee

## At a Meeting Held at Headquarters, July 11, 1946

A MEETING of the Executive Committee, of the Council was held in the rooms of the Society, July 11, 1946. There were present: D. Robert Yarnall, chairman; J. Noble Landis, A. R. Stevenson, Jr.; A. R. Mumford (Sections), C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

### Paper Shortage

Because of the continuing shortage of paper and in accordance with the recommendation of the Committee on Publications, it was voted to send a letter to members of the Society asking them for permission to take their names from the mailing lists of Transactions and *Journal of Applied Mechanics* if these publications are not needed or are available to them at other sources.

### Resolution of Thanks

Approval was voted for a resolution, adopted on the last day of the 1946 Semi-Annual Meeting, Detroit, Mich., which expressed sincere thanks and appreciation of the Society to all members who contributed to the success of that meeting.

### Standardization

Upon recommendation of the Committee on Standardization, it was voted to adopt "Surface Roughness, Waviness, and Lay, B46" as a standard of the Society and to transmit it to the American Standards Association for approval as an American standard.

### Appointments

The following appointments were approved for the record:

Special Research Committee on Lubrication, E. O. Waters, R. W. Dayton.

Power Test Codes Committees: No. 17 on Internal-Combustion Engines, G. J. Dashefsky; No. 22 on Gas Turbines, Martin A. Mayers.

A.S.A. Sectional Committee on Safety in Welding and Cutting, A.S.M.E. representative, James Partington; alternate, Harry Swan.

Engineers' Council for Professional Development, R. L. Goetzenberger (reappointed for 3-year term).

National Committee for Traffic Safety, A.S.M.E. representative, E. R. Granniss.

# China to Receive Large Part of John Ripley Freeman Library

THE Nanking Library of the National Resources Commission of China will soon be enriched by nearly two tons of engineering literature comprising more than 4000 items of books, periodicals, and documents packed in 19 cases which represent about one half of the library of the late John Ripley Freeman, past-president A.S.M.E., 1905, world-renowned civil and mechanical engineer, who in his lifetime was deeply interested in the flood-control problems of the Yellow River and served for many years as consulting engineer to the Chinese Government.

### E.J.C. Program

The shipment was arranged by The American Society of Mechanical Engineers acting for the Committee on International Relations of the Engineers Joint Council as part of Council's program for restocking of war-devastated libraries. The books were made available by the Engineering Societies Library. Arthur Ratner, president, Rentar Packaging Company, Brooklyn, N. Y., donated facilities, materials, and services for overseas packaging and transportation from the Engineering Societies Library to the shipside.

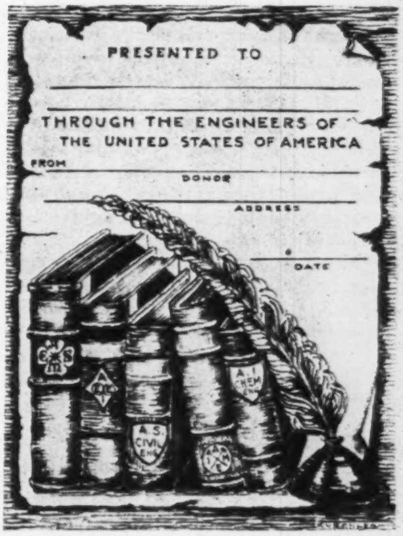
Mr. Freeman had been an indefatigable worker and collector of engineering literature. As consulting engineer to the Chinese Government he spent more than five years in China in connection with the surveys and investigations of the Grand Canal in Shantung, flood-control problems of the Yellow River, and designs for a railroad bridge on difficult foundations across that river.

When the Freeman Library, which had been stored in the Engineering Societies Library, was called to the attention of Dr. C. D. Shiah, chemical engineer and technical representative in the United States of the National Resources Commission of China, he expressed immediate interest in the books and asked to have them reserved for China. The American Book Center, Washington, D. C., is shipping the books to Shanghai. Chinese authorities will arrange for transfer to Nanking.

Clarke F. Freeman, member A.S.M.E., son of the late Mr. Freeman, catalogued his father's library and offered the contents to the Engineering Societies Library in 1942, with the understanding that the library of Brown University should have the privilege of selecting from it for additions to its collection.

### Several Libraries Benefit

Because of the late Mr. Freeman's habit of preserving several copies of most items, it was possible for both libraries to add to their collections without depleting the vast catalogue. In addition to the heavy consignment to China, 18 cases of the Freeman library, weighing more than 2000 lb, duplicating to a large extent the books and documents in the China shipment, have been shipped to the American Book Center, Washington, D. C., for distribution to the war-devastated libraries of the world. This material was also packaged by the Rentar Packaging Company and delivered freight prepaid to the American Book Center.



BOOKPLATE, ACTUAL SIZE $4\frac{1}{4} \times 5\frac{5}{8}$ IN., DESIGNED BY K. V. ECHLER FOR THE ENGINEERS JOINT COUNCIL TO MARK BOOKS CONTRIBUTED TO THE E.J.C. BOOK PROGRAM FOR THE RESTORATION OF WAR-DEVASTATED LIBRARIES

The Freeman Library has been the largest donation offered to the Engineers Joint Council book program. The Council urges American engineers to declare books or funds and to request shipping instructions from the Committee on International Relations, 29 West 39th Street, New York 18, N. Y.

To - U.N.R.R.A SHANGHAI
c/o C.N.R.R.A
% MIN. OF ECON. AFFAIRS
FOR
NATIONAL RESOURCES
COMM LIBRARY
NAN KING - CHINA

DR. C. D. SHIAH (*left*) ACCEPTS THE FREEMAN LIBRARY FROM STEWART REIMEL, SECRETARY, COMMITTEE ON INTERNATIONAL RELATIONS OF THE ENGINEERS JOINT COUNCIL

# Applied-Mechanics Division Semi-Annual Meeting Held in Buffalo, June, 1946

THE Semi-Annual Meeting of the Applied Mechanics Division of The American Society of Mechanical Engineers was held in Buffalo, N. Y., June 21 and 22, 1946. The headquarters for the meeting was at the Hotel Sheraton, where the technical sessions and the banquet were held Friday, June 21. The Saturday sessions were held at the Hotel Stuyvesant

Four technical sessions were held on strength of materials, theory of metals, fluid mechanisms, and elasticity and plasticity. Two of the sessions, namely, theory of metals and fluid mechanisms, included a number of invited papers and the efforts of those who contributed were rewarded by the considerable interest of those attending.

On Friday afternoon the Buffalo Section of the A.S.M.E. arranged an inspection trip through the Cornell Aeronautical Laboratory, where the fine aerodynamic and structural-analysis equipment was on display.

Following the banquet, L. A. Hawkins, consultant, research laboratory, General Electric Company, spoke on "The Future of Research." In his talk he brought out the part research must play in the future of engineering development and the part the A.S.M.E. Applied Mechanics Division must play in financing research. He noted the current status of the various science-research bills now before Congress. His remarks were much appreciated, as they served to bring members up to date on these important matters. Mr. Hawkins delivered a similar addresss during the A.S.M.E. 1946 Annual Meeting, the full text of which appears on pages 11 to 13 of the Jan., 1946, issue of MECHANICAL ENGINEERING.

The success of the Buffalo Meeting was due largely to the efforts of the Buffalo Section of the A.S.M.E. to whom thanks are due for arranging the local details.

## Progress Reported on Metals Engineering Handbook

SATISFACTION with progress on the A.S.M.E. Metals Engineering Handbook was expressed by L. K. Sillcox, chairman, A.S.M.E. Metals Engineering Handbook Board, at the Board's regular quarterly meeting held at his home in Watertown, N. Y., July 15 and 16, 1946.

The handbook, which is an important publishing project of the Society, is expected to meet the need of designing engineers and draftsmen as a source of technical information on metals arranged particularly for their convenience.

Chapters of the book have already been designated and assigned to experts for writing. To broaden the usefulness of the proposed handbook, the Board decided that both mass-effect and hardenability data should be covered.

Following the business meeting, Mr. Sillcox was host to the Board and working committees on a fishing expedition on the St. Lawrence River and Lake Ontario.

## General Armstrong Joins Staff of A.S.A.

DONALD ARMSTRONG, brigadier general, United States Army, who has just retired after 36 years of service, joined the staff of the American Standards Association on August 1, 1946, according to an announcement made by P. G. Agnew, secretary of the Association.

General Armstrong will assist Howard Coonley, member A.S.M.E., chairman of the A.S.A. executive committee, in expanding and developing the activities of the A.S.A.

## Engineering Societies Personnel Service, Inc.

***These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient, nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.***

**New York**
**8 West 40th St.**

**Chicago**
**212 West Wacker Drive**

**Detroit**
**109 Farnsworth Ave.**

**San Francisco**
**57 Post Street**

### MEN AVAILABLE[1]

MECHANICAL ENGINEER, M.E., M.S. (Stevens), Tau Beta Pi; 5 years' experience mechanical equipment, power machinery; seeking permanent development, application, or service-sales opportunity. Available few weeks notice. Consider any location travel. Me-79.

GRADUATE INDUSTRIAL ENGINEER, age 32, married; 5 years' experience consulting and staff-management engineering and 5 years' plant and production managerial experience in food-processing industry. Desire production position in food or allied industry. Me-80.

MECHANICAL ENGINEER, 25, B.S. M.E., former naval officer; 3 years' experience in operation and maintenance of high-pressure steam-turbine plant, afloat. Desire position in design, development, or production. Location immaterial. Married. Me-81.

MECHANICAL ENGINEER, 38, married; 20 years' diversified experience; design, tooling, planning, methods, plant layout for automobile, railroad-car, radio, refrigerator, and aircraft production. Available for position as assistant chief engineer. Me-82.

GRADUATE MECHANICAL ENGINEER, 22, background in electronics, experienced in design for production, SHF equipment. Two years' navy radar and communications equipment experience in service. Desires position with future in electronics. Me-83.

MECHANICAL ENGINEER. Extensive experience in operation, maintenance, repair construction, and design on power and steam engineering. Desires responsible position with progressive firm. Age 37, married, Massachusetts License, former Naval Officer. Me-84.

MECHANICAL ENGINEER, M.E. degree, experienced designing mechanical and electromechanical parts, project leader, personnel layouts or supervise drafting. High-quality work only. Me-85.

MECHANICAL ENGINEER, 28, married, no children. Desires start in plant-engineering field as Junior. Navy machinist mate. Pratt Institute two-year certificate in mechnical technology. Eastern or Western U. S. Me-86.

REGISTERED MECHANICAL ENGINEER, age 30, married; 7 years' experience in high-pressure steam-power-plant operation, betterment, and feedwater treatment. Now finishing work for master's degree and will be available Sept. 15. Desires position in South or Southwest which will make full use of training and experience. Me-87.

RESEARCH ENGINEER, 35, experienced in advanced mechanical problems such as fatigue, thermodynamics, and fluid mechanics, desires supervisory position. Me-88.

### POSITIONS AVAILABLE

ENGINEERS. (*a*) Engineer, graduate, for combination of teaching and research in grinding, preferable with machine-shop experience and ability to absorb principles of grinding rapidly and to describe those principles effectively. (*b*) Engineer, young, mechanical graduate preferred, to represent company in field, after suitable training period. Should have gage or tool experience, or practical experience in general machine-shop procedures. Must have good sales personality and plenty of imagination and initiative. Massachusetts. W-7514.

ENGINEERS. (*a*) Chief engineer, 35–50, graduate. Must be capable of heading an engineering department; conversant with machine and tool design and have demonstrated ingenuity, inventiveness, and executive ability. $10,000–$15,000 year. (*b*) Assistant chief engineer, 35–40, graduate, for planning, co-ordination with various departments, technical supervision and personnel administration. Must have experience and contact with technical work in various phases of mass-production manufacture of small accurate metal articles. (*c*) Factory superintendent, 40–50, mechanical graduate or equivalent, with good engineering background and experience in mass production of small metal articles to close tolerance. Should be capable of planning and directing quality production. Will supervise and co-ordinate activities of group of foremen. $10,000 year. Northern New Jersey. M-7516.

RESEARCH ENGINEERS. (*a*) Research engineer trained in mechanical-engineering phases of hydraulics and fluid mechanics, such as pumps, blowers, heat-transfer, instrument design, and power transmission. Some teaching of mechanics and hydraulics. (*b*) Research assistants and research associates. Two men pursuing studies toward master's or doctor's degrees desired, for research projects, together with limited amount of teaching. Experience in laboratory desired. $2100–$2700. Write enclosing photograph, scholastic and professional records, special qualifications and references. Iowa. W-7518.

---

[1] All men listed hold some form of A.S.M.E. membership.

Design Engineer, 30–40, graduate mechanical, with 5 to 10 years' refinery design experience, for development of flow diagrams, apparatus performance, and material specifications and for design of oil-refinery equipment. $5000–$6000 year. Philadelphia area. W-7523.

Division Engineer, 34–38, mechanical graduate, with plant-design and operation experience, covering milk drying and condensing, cheese making and processing, and the processing and disposal of whey. $7500 year. Illinois. Interviews, New York, N. Y. W-7533.

Mechanical Engineer, graduate, with 10 or more years' experience in designing and development of heavy machinery, for research and development work. $5000–$7000 year. Write giving personal, educational, and experience data; enclose photograph. Pennsylvania. W-7541.

Chief Engineer on materials handling. Will act as consultant and correlate all engineering on material handling in 24 plants of company. $10,000 plus, a year. Headquarters, Pennsylvania. W-7548.

General Manager for factory of 1200 employees normal capacity; graduate mechanical engineer, not over 45. Good administrative background and considerable experience in light metals for manufacture of small metal items. $8500 year plus bonus. New England.

Machine Designer, graduate mechanical engineer, not over 40. Experience on light automatic or semiautomatic machinery. Knowledge of materials essential. Knowledge of tool design prerequisite. Will work on board. $4800 year. Connecticut. W-7554.

Plant Engineer, preferable 35–40, with experience in steam boilers, alternating-current electric generators, steam turbines, electrical switching and control equipment, electric motors and motor controls, as well as good general plant-maintenance experience. Should have sufficient shop knowledge to direct machinists, welders, electricians, sheet-metal workers, etc. Some knowledge of drying operations desirable. Should be able to make plans and layouts for equipment changes and alterations and to design simple equipment. Position is in Philippines. Several months training in U. S. after which man will be required to go on job for several months single status. Transportation and living quarters furnished. Six months' vacation every four years. W-7559.

Plant Industrial Engineer, 30–40, mechanical, chemical, or industrial graduate, with knowledge of packaging equipment, materials handling, cost-analysis methods, cost controls, and time study. Should have 5 years' experience in active industrial engineering work in chemical or process-type industry and several years' production operations. $6000–$9000 year. East. W-7564.

Engineers. Must have knowledge of Hebrew. (*a*) Production engineer with at least 10 years' experience in American factory practices, for food-processing plant. Must have management experience. (*b*) Industrial engineer with 10 to 15 years' experience in management work for candy factory. $15,000 year. (*c*) Associate professors and instructors with electrical, mechanical, and chemical-engineering experience. Location, Palestine. W-7567.

Plant Engineer to be responsible for all plant engineering, maintenance, and betterments. $4500–$6000 year. Connecticut. W-7580.

Mechanical Engineer, graduate or equivalent, with 4 years in laboratory drafting and designing of radio receivers and component parts, for advances development relative to component parts and special features for broadcast receivers. Must be able to draw and understand schematic diagrams and be familiar with tolerances for small parts. Southern New Jersey. W-7596 (*b*).

Equipment-Design Engineers, graduate with broad background in design of automatic equipment for glass-manufacturing and food-packing and packaging industries, to be responsible for design of new automatic equipment, redesign of existing models, and guidance of designs through layout and detailing stages. Connecticut. W-7608.

Engineers. (*a*) Junior mechanical engineers, about 25, preferably single, with few years' operation experience, although Army Ordnance experience would be satisfactory, for sale of lubricating oils and engineering service to manufacturing plants on lubricating problems. Illinois. (*b*) Mechanical engineer, 30–35, experienced in sales and service, and familiar with coal-mining machinery. West Virginia. (*c*) Mechanical engineers, under 35, single with several years' experience, preferably in machine work. Location, Far East. $3000–$6000 year depending upon qualifications. W-7616.

Plant Engineer with thorough technical knowledge and understanding of operations common to by-product coke-oven plant. Should have experience along research lines of resultant by-products, so that company's market might be expanded accordingly. Mexico. W-7619.

Mechanical Engineer experienced in power-station design and competent to take over and handle all design details under direction of chief mechanical engineer. Permanent. $7000–$9000 year. Illinois. W-7624.

Professor, industrial-engineering graduate preferred, with broad teaching, manufacturing, and management experience, to take charge of industrial-engineering program. $4000–$5000 year. North Carolina. W-7640.

Executive Vice-President, 45–50, for manufacturer of industrial chemicals, operating several branch plants and employing 1000–2000 people in producing plants. Will be responsible for direction and co-ordination of all production, sales, purchasing, and traffic activities. Must have sound knowledge of type of administrative problems involved in corporation producing industrial chemicals, with particular reference to marketing, production, etc. Salary, open. New York, N. Y. W-7644.

# Candidates for Membership and Transfer in the A.S.M.E.

The application of each of the candidates listed below is to be voted on after Sept. 25, 1946, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

### KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

### NEW APPLICATIONS

*For Fellow, Member, Associate, or Junior*

Atkinson, James W., Gary, Ind.
Aurand, H. S. (Maj. Gen.), Fort Myer, Va. (Rt)
Baker, A. Francis, New York, N. Y.
Baldwin, H. A., Detroit, Michigan
Balkan, O. A., Paterson, N. J.
Barnett, N. M., Chicago, Illinois
Bartels, Jerome, Brooklyn, N. Y.
Beale, Evelyn S. L., Nr. Staines, Middlesex, Eng.
Belock, Harry D., Brooklyn, N. Y.
Beltran, J. del C., New York, N. Y.
Berggren, W. P., Azusa, Calif.
Birdsall, E. H., San Diego, Calif.
Broderick, John J., Springfield, Mass.
Brumback, Oscar B., El Dorado, Kan.
Carson, J. P., Haddonfield, N. J.
Cassidy, Edward J., Queens Village, N. Y.
Chibber, S. P., Milwaukee, Wis.
Colby, Joseph M. (Col.), Grosse Pointe, Mich.
Comfort, Newell C., Corton, W. Va.
Congdon, Harold R., Flushing, N. Y.
De Beer, J., Birdsboro, Pa.
Donovan, Allen F., Kenmore, N. Y.
Dotten, John M., New York, N. Y.
Droescher, L. A., Bala Cynwyd, Pa. (Rt & T)
Dubus, J., Brussels, Belgium
Early, Joseph, Fairmont, W. Va.
Eaton, John F., Tulsa, Okla. (Rt & T)
Ehrhardt, John J., Arlington, Va. (Rt)
Fisk, Louis C., East Orange, N. J.
Garrison, Charles L., San Francisco, Calif.
Garza, R. G., Mexico, D. F.
Gilbert, W. W., Ann Arbor, Mich. (Rt and T)
Gillick, L. H., Evanston, Illinois
Gooch, Kendrick J., Ansonia, Conn.
Greeman, G. A., Waukesha, Wis.
Green, Thomas D., West Hartford, Conn.
Grimaldi, John V., Floral Park, N. Y.
Hagg, A. C., East Pittsburgh, Pa.
Hardy, A. A., Tulsa, Okla.
Henning, Joachim F. H., Evansville, Ind.
Hewes, William L., Wilmington, Del.
Holmes, James M., Toronto, Ont., Can.